Cash Transfers and Crop Production in Senegal

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Kate Ambler
IFPRI

Alan de Brauw
IFPRI

Susan Godlonton
Williams College and IFPRI

Abstract: We analyze the impacts of a program that offered cash transfers supported by farm management plans to smallholder farmers in Senegal. Transfers were large, approximately $200, given in a lump sum, and targeted specifically towards improvements in agricultural production. Program impacts are evaluated through a cluster randomized control trial where one third of farmers received only advisory visits, a second third received the visits and an individualized farm management plan, and the final third received the visits, the plan, and the cash transfer. After one year agricultural production and livestock ownership was higher (by significantly more than the amount of the transfer) in the transfer group compared to the group that received visits only. The livestock gains persisted in the second year of the program, though production increases may not have. An analysis of mechanisms suggests that increases in productivity came through increased investments in agricultural inputs, including chemical fertilizer.

Ambler: Markets, Trade, and Institutions Division, International Food Policy Research Institute (k.ambler@cgiar.org). de Brauw: Markets, Trade, and Institutions Division, International Food Policy Research Institute (a.debrauw@cgiar.org). Godlonton: Economics Department, Williams College and Markets, Trade and Institutions Division, International Food Policy Research Institute (sg5@williams.edu). We thank Anna Vanderkooy, Cheng Qui, and Michael Murphy for excellent research assistance and program management. We additionally thank Alphonse Aflagah, Ian Concannon and Samba Mbaye and his team. This project would not have been possible without the support of our partners including Macadou Gueye, Papa Assane Diop, Ousmane Pouye, and Guillaume Bastard. This project was funded by the UK Department for International Development (DFID) Brazil.

I. Introduction

1.5 billion people in poor countries live in smallholder households and these households produce 80 percent of the food in sub-Saharan Africa and Asia (FAO 2012). While many programs aimed at reducing rural poverty seek to diversify farmer income, increasing smallholder production remains a key component of improving farmer livelihoods. Many approaches to increasing production have centered on either relaxing information or capital constraints faced by farmers when making investment decisions.[2] Information constraints are most often addressed through technical advice provided through some kind of extension platform, but evaluations of these programs often show low adoption and modest impacts. Increased access to credit is a common approach to capital constraints, but high interest rates and a history of modest impacts limit the effectiveness of these programs. In this paper, we take a new approach and evaluate the impacts of a two year program that combines a large, one-time cash transfer to smallholder farmers with farm management advice in Senegal.

The goal of this program is to graduate poor farmers from subsistence-level production to a situation where they are selling excess output. We partnered with the Fédération des Organizations Non-Gouvernementales du Sénégal (FONGS), an umbrella organization of smallholder farmer associations to implement a project with three main components. First, participating farmers receive monthly advisory visits from an *animateur*, who are farmers from the general area trained by the implementing organization, but who are not professional extension workers. These visits center on farm management advice. Second, at the beginning of the season farmers complete a farm management plan with their *animateur* that is intended to assist them with better managing their resources and completing activities according to a schedule. Third, farmers

[2] A third set of programs address seek to alleviate risk inherent in many agricultural investments, typically by offering farmers an insurance product.

also receive a large, one-time transfer of 100,000 CFA (approximately 200 USD), timed to coincide with planting. While the transfer is not conditioned, farmers are told the funds are for investment in their farms. The advisory visits and the farm plan were administered for two years while the cash transfer was given only in the first year. The objective of this program is to provide intensive support for a pre-determined period of time and leave farmers sustainably better off.

To be able to evaluate the additive impacts of the farm management plan and the timed cash transfer, we conducted a cluster randomized control trial. 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] This research design allows us to disentangle the effects of receiving only the farm management plan from receiving the plan and the transfer. Considering that the farm management plan might take time for households to adhere to whereas the cash transfers provide immediate assistance to their farm, we might expect differential impacts of the project components over time.

An important component of the advisory visits received by all farmers is a "basic agricultural assessment" (BAA) administered by the animateurs with the household. The BAA is a survey-like tool that provides the animateurs with an overview of the household's situation and is also intended to make farmers more aware of their own output relative to their expenses. We use the BAA administered at the beginning of the project as the project baseline and track impacts with the BAA conducted at the end of the first program year (midline BAA) and at the end of the second program year (endline BAA). Researcher-supervised surveys were conducted with a subset

[3] There is almost a one-to-one correspondence between villages and *animateurs*; specifically, 109 *animateurs* worked across 120 villages; 11 *animateurs* covered two villages. We randomized at the *animateur* level so that specific *animateurs* covering two villages would not have to implement two different versions of the program.

of households at midline and all households at endline to verify the BAA data and investigate outcomes not included in the BAA.

After one year of implementation, we find large, positive impacts on agricultural outcomes among farmers who received the cash transfer and the farm management plan. Both the midline BAA and the midline survey found large increases in the gross value of agricultural output (GVAO) and GVAO per hectare. The midline survey data also shows that households in the cash transfer group were able to invest in additional livestock. Other results suggest these impacts came through increased investments in agriculture. In particular we find large increases in the use of chemical fertilizer. We did not find impacts from the farm management plan alone after one year, although as noted above such gains might take more time to develop.

Following the second year of implementation endline results find only suggestive and much reduced impacts on agricultural output. The increase in fertilizer use is smaller and no longer statistically significant, although base use in the advisory visits only group also increased from year 1 to year 2. Large and robust increases in livestock ownership for those who received transfers persist into the second year. As in year 1 there is no robust evidence of positive impacts for those who received the management plan but no transfer.

Cash transfers are an increasingly common element of development programs. While they were first popularized as conditional programs to provide incentives to enroll children in school and to improve young child health (see Fiszbein et al. 2009 for a review of these programs), programs without conditions are increasingly widespread. The transfer we study can be characterized as a framed or labeled transfer, where conditions were not enforced but where recipients were encouraged to use the funds for agricultural investments. Recent work has shown

that framing can be an effective and simple method of directing transfer funds (Benhassine, Devoto, Duflo, Dupas, and Pouliquen 2015).

Very few studies have examined transfer programs whose main goal is to support agricultural productivity. A number of studies have, however, examined the impact of cash transfers with different core goals on agricultural outcomes. These papers, including studies of the Malawi Social Cash Transfer Scheme, the Mexican Progresa program, and the Zambian Child Grant have all found positive but modest impacts of transfers on agricultural investments or production (Handa, Seidenfeld, Davis, and the Zambia Cash Transfer Evaluation Team 2015; Boone, Covarrubias, Davis, and Winters 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).

These programs all differ from the project described here in that they are small, monthly transfers intended to provide continued income support compared to a lump sum payment intended to increase income and reduce the need for long-term support. Recent work in Kenya finds 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.

The study most closely related to ours is Karlan, Osei, Osei-Akoto, and Udry (2014). Karlan et al. investigate the impacts of a large cash grant to farmers in Ghana and compare the impact of the grants to grants of rainfall insurance. The authors find modest effects of the cash grant on agricultural investment and output compared to robust impacts of the insurance grant. These results suggests that, at least in that context, farmers are more constrained by risk than capital. However, our context differs in important ways. First, the farmers in this study are much

better off at baseline, both land holdings and harvest value are much higher in our sample. Second, our farmers live in households that are more than twice as large on average and may therefore have other ways to manage risk.[4] Finally, the grants in this study are accompanied by additional support services which may allow them to be used more effectively.

These additional support services (the basic agricultural assessment, the advisory visits, and farm management plan) are developed from the viewpoint of the small farm as a business and are intended to provide the farmers with the tools they need to better manage their farms. If farmers can better manage their limited resources, productivity may increase. This is a departure from standard agricultural extension programs that provide technical advice, but is related 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 firm profits (see McKenzie and Woodruff 2013 for a review).

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-terms impacts of cash grants on firm profits and survival (de Mel, McKenzie, and Woodruff 2008; de Mel, McKenzie, and Woodruff 2012). Other projects have combined cash grants with business training. De Mel, McKenzie, and Woodruff (2014) find little impact of a business training program for women in Sri Lanka. When the program is combined with a cash grant, profits go up initially, but the increases are not sustained. Very poor, conflict-affected women in Uganda show increased business income from a project that included cash and business skills training (Blattman, Green, Jamison, Lehmann, and Annan 2016).

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

The support services and the project's time limited implementation period are similar to a group of graduation models for the ultra-poor that combine 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 finds 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, Duflo, Goldberg, Karlan, Osei, Parienté, Shapiro, Thuysbaert, and Udry 2015). However promising the results, impacts vary 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 and which provides cash, instead of in-kind, transfers.[5] Additionally, the research design employed here allows for some differentiation of the different elements of the program, specifically focusing on the impact of the cash grant relative to the other program components.

The paper proceeds as follows. Section II describes the program and implementation in more detail, Section III describes balance checks and comparisons between different data sources, Section IV presents the empirical strategy, Section V the results at midline, Section VI the results at endline, and Section VII concludes.

II. Project details

A. Treatment details and randomization

This project was implemented by FONGS, an umbrella group of 31 autonomous farmer associations operating in 35 of 45 departments. Eight associations participated in this project

[5] Some evaluations of graduation-style programs have given cash but these are focused on income diversification opportunities and not agriculture directly (Blattman, Green, Jamison, Lehmann, and Annan 2016).

covering five regions, all in the so-called "peanut basin", a zone of central and western Senegal with a long history of rain-fed food production, centering on groundnuts. 15 villages in each association were chosen to participate and five households in each village were selected for a total of 600 households. These villages were each assigned to an animateur and each animateur (and his/her households) was then randomly allocated into one of three treatment groups. Participating villages are shown by association in Figure 1a.

Group 1: Advisory visits only

Project participation begins with the administration of the basic agricultural assessment (BAA). The BAA is a tool, developed by FONGS, that collects information about the household's production and expenses and is used to track their progress and also as a tool for farmers to better understand their financial situation. The BAA is administered by an "animateur," who is someone from the area (though not usually the same community as the farmers) and is 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 (Perry, Zulliger, and Rogers 2014). After the implementation of the BAA households in this group received monthly advisory visits from the animateur. These visits are an opportunity for the farmer to discuss any issues with their farm. Animateurs are trained to provide assistance with questions related to farm management, but have not received technical training to provide agricultural advice. Themes covered in these visits include agricultural decision making, information regarding inputs, and household budgeting. In some cases, animateurs may assist the farmer by linking them with other services, such as technical support or credit access. The advisory visits continue for two agricultural seasons and two additional BAAs are administered following harvest of both the first (midline) and second (endline) season.

Group 2: Advisory visits and farm management plan

Farmers in this group receive all the same services as farmers in Group 1 and additionally receive an extra visit from their animateur to fill out a farm management plan at the beginning of agricultural season. The management plan is focused on improving productivity by helping farmers to better manage their resources. Farmers think through the challenges they have had and the consequences of those challenges and subsequently make commitments for improvements. They also make a plan for both when activities will occur and the amount and timing of necessary expenditures. Animateurs are encouraged to use the following monthly advisory visits to refer back 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 the third group received all the services described for Group 2 as well as a cash transfer of 100,000 CFA (approximately 200 USD).[6] This was a large transfer, equal to approximately 15% of gross agricultural output at baseline. The cash transfer was distributed shortly following the implementation of the extension plan. It was timed near the beginning of the season to help the farmer implement the main goals outlined in the farm plan. While the transfer was not conditioned on any particular farmer behavior, it was heavily framed as being meant for agricultural investment. 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. This was done primarily to ensure that elements of the management plan were not included in interactions with farmers in the advisory visits only group. As such, animateurs assigned to administer only the advisory visits were not invited to the trainings

[6] The exchange rate was approximately 488 CFA to 1 USD at the time transfers began.

where the management plan was discussed. In general, each animateur worked in a single village, meaning that this was close to a village-level randomization. However, 11 animateurs managed two villages; there were 109 total animateurs. Animateurs were assigned to villages prior to randomization.[7] Randomization was stratified by association and number of villages per animateur. Village location by treatment status is shown in Figure 1b.

B. Project timeline

Project implementation occurred in the 2014-2015 and 2015-2016 agricultural seasons. The timeline of events can be seen in Figure 2. The project began with the administration of the baseline BAA in June 2014. Following that, the management plans were completed in July 2014 and the cash transfers administered in August 2014. The advisory visits were conducted on a monthly basis from August 2014 to January 2015. The midline BAA was conducted in March 2015 and a midline survey to be described below was completed in May 2015. In the second year, the farm management plan was completed in June and July of 2015. Monthly advisory visits took place from July 2015 to October 2016. The endline BAA was completed in February 2016 and the endline survey in April 2016. Advisory visits continued after endline data collection to support FONGS' goal of continued engagement with farmers, but the data collection was scheduled closer to harvest to more accurately measure agricultural production.

C. Data sources

The data used in this paper take advantage of five main sources of data, the baseline BAA, the midline BAA, the midline survey, the endline BAA, and the endline survey. One contribution of this project is that we are able to take data collected by the implementing organization as part

[7] There is only one case where the 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 the new village.

of the intervention itself and utilize it in our evaluation, in combination with more traditional survey data. The baseline BAA serves as the project baseline and the midline and endline BAAs are used to track impacts. The BAA collects information on agricultural production, livestock, credit, and migration. It also includes some information on expenditures, although the list was not comprehensive and FONGS' goal is to collect information only on necessary expenditures. The main difference from a traditional survey is that the entire household is encouraged to participate and the data collection is meant to be a learning experience for the family.[8]

Although the BAA data is useful, in order to convincingly measure program impacts it is also necessary to collect externally managed survey data. The research team therefore 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 on respondents. The sample of respondents for the midline was randomly selected by village and stratified by association and treatment. Forty-eight villages were included in the sample which is two villages per association-treatment arm cell. All five households in each selected village were interviewed. In order 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 very few cases at midline was the survey conducted by the animateur was also responsible for working with the respondent family. The animateurs were very closely managed by an external team of supervisors at a ratio of one supervisor to every two enumerators to compensate for their relative lack of data collection experience. The survey training and all management was conducted by the research team.

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

The surveys were designed to capture all of the outcomes contained within the BAA as well as many additional indicators. For example, use of agricultural inputs is an important outcome that is included only on the surveys. In many cases although the BAA and the midline capture the same information, the questions were structured in slightly or very different ways. Additionally, in both years there was a one to two month gap between the BAA and the survey, a time in which households may have finished harvesting and particularly selling their crops. Therefore, we do not expect the two data sources to contain exactly the same information, but they should be similar for comparable variables. We will use the survey data to validate the data in the BAA and thereby allow us to use the full sample of 600 households at midline. At the same time, the survey data is more detailed and will be used to investigate the mechanisms behind the main results.

Attrition between data collection rounds is negligible. All 600 households were interviewed during the midline BAA and 239 of a targeted 240 were interviewed during the midline survey. 599 households were visited during the endline BAA (one household had left the project) and 598 households were interviewed during the endline survey. The missing households from the survey data in both years were due to household level refusals.

III. Data description

A. Treatment balance

It is first important to show that the randomization of the treatments was successful in creating comparable treatment groups. Table 1 displays the results of balance tests for the midline sample. The results for the full sample are comparable and shown in Appendix Table 1. Columns 1 through 3 show the means of the same baseline variables as Table 1 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 all three groups are equal to each

other. Overall the groups appear to be well balanced with very few p-values less than 0.10. There is some evidence that farmers in group 2 own less livestock than farmers in the other groups. Regressions will control for baseline characteristics (household size, whether household head is polygamous, whether household head is female, and the household head's education level) to mitigate any baseline differences between the treatment groups.

B. Midline sample balance

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 not very different from households that did not. Given the random selection of households by the research team, no large differences are expected. Table 2 presents the average of baseline characteristics (collected in the baseline BAA before project implementation began) by whether or not the household was in the midline sample. The first column presents the overall average for the whole sample, column 2 presents the average for households not in the midline, column 3 the average for households in the midline sample, and column 4 shows the p-value for the test of equality between the two groups. Overall, the samples are very similar, with only four (number of adults in household, number of females in household, gross value of agricultural output per hectare, and total value of agricultural expenditures) out of 21 variables exhibiting p-values below 0.05.

This table can also be used to examine the summary statistics of our sample. 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 utilized a definition of the household that encompasses extended families, both monogamous and polygamous, living together in family compounds. Families cultivate an average of 8.5 hectares on which they grow an average of three crops. Gross value of agricultural

output is approximately 1,460 USD, approximately 40 percent of which was sold. Livestock ownership is important, with families owning around 3.6 tropical livestock units, valued at approximately 2,270 USD.

C. Comparison of data sources

The analysis in this paper will utilize both the midline and endline BAAs and the midline and endline surveys. Given that the BAA differs in important ways from a typical survey it is important to show that the data collected is accurate. As such, in Table 3, we compare variable means for all outcomes we will examine that are common to the two datasets. All continuous variables are winsorized at the 99th percentile to reduce the influence of some very high outliers. Column 1 shows the midline BAA mean, column 2 the midline survey mean, and column 3 shows the p-value for the t-test that the two values are equal. Columns 4 to 6 repeat the same information for the endline BAA and endline survey. Although there are many significant differences between the data sources, overall the magnitude of the differences is small. Given the differences in timing of the two surveys some differences are to be expected. Additionally, variation in the ways the questions are asked could lead to some differences.

Values and amounts in specific crop or livestock categories in the BAAs tend to be overstated relative to the values in the surveys. This may be due to superior math skills and training of the midline enumerators that allowed them to more appropriately estimate these numbers. However, the aggregate measures are generally higher in the survey data. The surveys contained more specific categories for crops and animals than the BAAs which relied more on write in categories for crops and animals outside of the main categories shown here. While not shown in this table, a general pattern in the comparison of the two data sources is that respondents are much likely to report having grown a crop (hay and watermelon are examples) when it is specifically

listed on the survey. This is particularly true for food and non-food expenditures; the midline survey contains a much more comprehensive consumption and expenditure module than the BAA which only collects information on a limited set of consumption categories. It should be noted that the agriculture equipment value is much higher in the BAA because the equipment lists were not directly comparable, specifically they included draft animals in the BAA, whereas all animals were included in the livestock module in the surveys.

IV. Empirical strategy

We examine the impacts of this program by exploiting the randomized implementation and estimating simple ordinary least squares regression models. We examine the impact of the project on various agricultural outcomes using the following model run separately at midline and endline and with the BAA and survey data:

$$Y_{ict} = \alpha + \beta_2 T_{2c} + \beta_3 T_{3c} + \delta Y_{ic0} + \gamma X_{ic} + \delta_c + u_{ic}$$

where i indexes households, c indexes the animateurs, and t indexes the year (midline or endline). Y_{ict} is the outcome in year t either in the BAA or the midline survey. T_{2c} and T_{3c} are indicator variables for treatment groups 2 (advisory visits and management plan) and 3 (visits, management plan, and cash transfer) respectively. β_2 and β_3 therefore represent the average difference between outcomes for farmers in that treatment group relative to group 1. Regression tables will also report a test for equality of β_2 and β_3. Y_{ic0} is the baseline value of the outcome in question, included when available. X_{ic} is a vector of baseline control variables included in all specification that includes: household size (numerical value of total household size), whether household head is polygamous, whether household head is female, and the household head's education level (score ranging from 1 (no education/less than primary school) to 6 (post-secondary study)). δ_c are association fixed

effects in specifications using the BAA data and enumerator fixed effects in specifications using the survey data.[9] Standard errors are clustered by animateur.

Each regression table will follow a similar structure with results from the midline BAA 2015 using the full sample presented in the top panel, results from the midline survey presented in the second panel, results from the endline BAA presented in the third panel, and results from the endline survey in the fourth panel. To limit the influence of several large outliers in this sample, all continuous outcome variables are winsorized at the 99th percentile. All money values are expressed in dollars.[10]

V. Results after one year

The first step in the analysis of the impacts of this program is to examine the short term effects at midline, directly following harvest in the year when the cash transfers were given out.

A. Impacts on agricultural production

Given that the primary goal of this program is to increase agricultural production we begin by directly addressing this question. Table 4 shows the results for production in kilograms of the five main crops, groundnuts, millet, sorghum, maize, and manioc respectively across columns 1 through 5. A summary measure, the gross value of agricultural output (GVAO), that includes all crops grown by the household is presented in column 6.[11] Across both the BAA and the survey,

[9] 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.

[10] Exchange rates were determined by the rate on the first of the month in the month a data collection exercise began. For the midline and endline data collections the BAA exchange and survey exchange were averaged and one exchange rate was used for each period. The baseline exchange rate was 482 CFA to 1 USD, the midline exchange rate was 586 CFA to 1 USD, and the endline exchange rate was 593 CFA to 1 USD.

[11] Gross value of agricultural output was calculated using the method 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 come up with a 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 information

the coefficients for the cash transfer group are positive, with the exception of manioc. However, these increases are statistically significant for millet and maize only in both data sources. The consistent positive coefficients provide suggestive evidence of large increases in crop production, but we lack the precision to make definitive statements.

Statistical power improves when examining the impact of the treatments on the summary GVAO measure. The cash transfer treatment has a large and statistically significant impact in both the BAA and the survey. Group 3 households' average GVAO is about 400 USD (40%) higher than the Group 1 mean in the BAA data and about 550 USD (60%) higher than the Group 1 mean in the midline data. Overall these results are striking, they suggest a 200% return on the cash transfer with the BAA data and a 275% return on the cash transfer with the midline data.[12]

We see some evidence of differences between Group 2 (advisory visits and management plan) and Group 1 (advisory visits only) across outcomes. Coefficients from the survey analysis (but not the BAA analysis) are consistently positive, but marginally statistically significant only for the aggregate measure. In the BAA data we can confidently reject that that the coefficients for management plan group and the cash transfer group are equal, indicating that the treatment with the cash transfer had an effect beyond that of the management plan. However, we cannot reject this equality in the midline data due to reduced power from a smaller sample size and the positive estimated coefficient for management plan group. In Appendix Table 2 we observe a similar pattern of results for crop sales.

(village, district, department, region, full sample). As 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.

[12] These figures overestimate the true return to the transfer, as they do not take into account some transaction costs related to delivery of the transfers. They also ignore the other costs of the project.

Next, in addition to changes in overall production we examine changes in productivity by analyzing impacts on the GVAO per hectare. These results are show in Table 5. 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 majority of farmers in our sample, groundnuts and millet. Those results are presented in columns 1 and 2 respectively and the overall GVAO per hectare is presented in column 3. There is evidence that cash transfer increased output per hectare as the transfer group coefficients are positive and statistically significant for groundnuts in the BAA and for GVAO per hectare in both datasets. These results suggest that the transfer increased productivity in the first year. Interestingly, despite some suggestive evidence of an increase in overall production for the management plan group (Table 4), there is no such evidence for productivity. The point estimates for the management plan group for the both the BAA and the survey are close to zero and negative.

As a final production-related outcome we examine the impacts of the program on livestock ownership, an important component of farm livelihood for these Senegalese farmers. The results are presented in Table 6. In columns 1 through 6 we present results for the six main animals owned by households (cows, sheep, goats, poultry, donkeys, and horses). Donkeys and horses are included only in the survey and not in the BAA so these measures differ somewhat. In columns 7 and 8 we present two aggregate measures, tropical livestock units and total livestock value. Tropical livestock units provide a convenient way of standardizing different animals to come up 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.[13]

[13] Exchange ratios used to convert number of animals into livestock units were the following: 0.7 for cattle; 0.5 for donkeys; 0.2 for pigs; 0.1 for sheep or goats; 0.01 for poultry; 0.01 for rabbits.

In the BAA data, there is no evidence that either treatment led to increases in livestock ownership. However, the midline data shows very different results. For the transfer group the coefficients on all types of livestock are positive (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% increase in total livestock units and a 46% increase in total livestock value. While the aggregate coefficients for the management plan group are positive, none are significant and despite the low number of observations, the coefficients for sheep, goats, poultry, horses, and tropical livestock units are statistically significantly larger in transfer group compared to management plan group. Households in the transfer group are making large investments in livestock and these investments include both livestock that can be viewed as a separate enterprise for sale or by-products (poultry and cows for example) and livestock that are tools in the process of agricultural production (horses).

The robust positive results for livestock in the midline data are confusing when viewed against the null result in the BAA data. One element of this difference is the inclusion of donkeys and horses in the survey data, however given positive impacts for other animals such as cows and poultry this cannot account for the whole difference. Average livestock ownership is higher overall in the BAA data than in the visits only group of the midline survey. One possible explanation is therefore that in the time between the BAA and the survey farmers who were not in the transfer group had to sell off livestock for income while the increased production for the transfer group farmers protected them against this. However, this difference is not large enough for such an explanation to account for all of the transfer group effect. It is also possible that the transfer group farmers purchased more livestock between the BAA and the survey.

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 stocks. These results are large compared to the levels in advisory visits only group. The cash transfer is successful in inducing large increases in agricultural production in the short run, a contrast to the modest impacts found in Ghana (Karlan et al. 2014). These large impacts compare to only small effects of the management plan implemented without the cash transfer, although effects of the management plan may take longer to appear. However, it is possible that it is the complementary aspects of the program (the advisory visits and the management plan) that did not accompany the cash grants in Ghana that allowed the cash transfer to be used so effectively. Although given the 600 household sample size it was not possible in this setting to study the impacts of the cash transfer without the supporting activities,[14] we can nevertheless use the detailed complementary data collected during the midline survey to examine the potential mechanisms behind these increases in crop production and livestock ownership.

B. Mechanisms

To understand the mechanisms behind the increase in production we use the survey data. First we examine the impact of the cash transfer on expenditures and assets in Table 7. Here we focus on the midline survey data only which has much more complete and detailed expenditure and asset modules than the BAA. Focusing first on expenditures specifically related to agriculture in column 1, we find that the transfer group farmers have statistically significantly higher agriculture expenditures, suggesting that they are investing more in agriculture than farmers who

[14] A companion study in Malawi is designed to directly answer this question (Ambler, de Brauw, and Godlonton 2016).

received advisory visits only. There is no evidence of increases in these measures for farmers in the management plan group.

Columns 2, 3, and 4 present the results for the impact of the treatment on owned asset value, split by agricultural and non-agricultural (columns 2 and 3) and total assets (column 4). All of these coefficients are positive (in both groups 2 and 3) and statistically significant at the ten percent level for the transfer group only for agricultural equipment (column 2) and total assets (column 4). Similar to the increase we saw in work animals in Table 6, this is further evidence that the cash transfer was used to make investments in inputs and equipment, contributing to the increase in agricultural production.

The impact of the cash transfer on consumption and expenditure is displayed in columns 5 (total), 6 (food only), and 7 (non-food only). These results are repeated for per-capita measures in columns 8, 9, and 10. We see positive but not significant impacts of the cash transfer on total expenditures and food expenditures. Non-food expenditures increased by 25% in the transfer group, 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 non-agricultural expenditures questions: all 76 food items are based on a 7 day recall and 46 out of 55 non-food items are based on a recall period between 7 days to 3 months. As such, the vast majority of non-agricultural expenditures that may have happened in the months after receiving the cash transfer in August 2014 are not captured in this survey.

This analysis of expenditures suggests that investment in agriculture other than equipment may be one main mechanism driving the production increases in the transfer group. To investigate this further we examine agricultural input use to understand some of the ways in which farming behavior might be changing. The midline survey captured detailed and crop-level data on chemical

fertilizer, non-chemical fertilizer, and pesticides. We examine overall usage of chemical fertilizer, amount of chemical fertilizer used, use of non-chemical fertilizer, and use of pesticides in Table 8. There is a 17 percentage point increase in the probability that farmers in the transfer group used chemical fertilizer, an increase of 42% over fertilizer use in the visits only group. The coefficient on amount of fertilizer used is large and positive, but not statistically significant. There is no increase in use of non-chemical fertilizer or pesticides or any impacts for the management plan group. This table suggests that the cash transfer is having an impact on the extensive margin of fertilizer use. Use of chemical fertilizer in much lower in the advisory visits only group (44%) compared to non-chemical fertilizer (67%) and pesticides (87%). This difference in the advisory visits only group usage provides one explanation for why the transfer group farmers chose to invest in chemical fertilizer instead of other inputs.

This mechanism of chemical fertilizer use driving crop production impacts is further explored in Table 9, where we report on the treatment impact of chemical fertilizer by crop. Again, we see impacts on the extensive margin for fertilizer use, which can be narrowed down to positive, significant differences for groundnuts and millet. Approximately 30 percent of transfer group households used chemical fertilizer on their groundnuts, as compared to 16 percent for the visits only group and 15 percent for management plan group. 48 percent of transfer group households used chemical fertilizer on their millet, as compared to 29 percent for advisory visits only and 30 percent for the management plan group.

These results provide strong evidence that farmers used the cash transfer to invest in agriculture generally and specifically in chemical fertilizers which resulted in increased production and larger stocks of livestock. In the midline survey, farmers were specifically asked what they spent the cash transfer on. We can use this data to check whether farmers report using their transfer

to invest in agriculture. Figure 3 reports the frequencies that families reported spending their transfer (primary and secondary use) in a number of categories. While the most common category overall is household expenses, fertilizer purchase is also very commonly reported. Other common uses are seed purchases and investment in agricultural equipment. This is strong evidence that farmers are using the transfer to invest in their farms and complements the regression results described above.

VI. Results after two years

This project provided large cash transfers that are cost effective for program implementers only if they can be sustained across time. Because farmers did not receive transfers in the second year of the program, examining the second year impacts is the first step in a long term analysis. Additionally, the endline results will speak to the effectiveness of the farm management plan which may have needed more than one year to be effective. 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 (Table 4) do not show the same robust increase for the transfer group as at midline. The endline BAA coefficients are positive (except for sorghum) and there is a 17% increase in GVAO relative to the visits only group that is statistically significant at the 5 percent level. However, the coefficients in the survey data, while largely positive (except for groundnuts and sorghum), have large standard errors and are smaller compared to the midline results. Overall there is only suggestive evidence of continued increased production, and the size of that increase is certainly smaller than at midline. Interestingly the BAA results are also suggestive of an increase attributable to the farm management plan (group 2), though the coefficient for GVAO is not statistically significant. This pattern is not repeated in the survey data. The results for productivity in Table 5 follow a similar pattern to overall production. The BAA

data shows a statistically significant increase in GVAO per hectare, while the endline results are too noisy to draw any conclusions.

While agricultural production could easily vary from year to year, investments made in livestock and durable assets should persist in the absence of major negative shocks. First we examine livestock stocks at endline (Table 6). There is some evidence in the BAA data that the transfer led to increased livestock, all the coefficients are positive and the impact on tropical livestock units is significant at the 10 percent level. Again at endline there is robust evidence of an increase in livestock for the transfer group in the survey data. Sheep, goats, tropical livestock units, and total value are all positive and statistically significant. Tropical livestock units go up by 24% and total livestock value increases by 31%. Interestingly, two animals that saw large increases at midline, poultry and horses, are no longer different than the visits only group. The coefficients are small and statistically insignificant.

Turning to assets and expenditures in Table 7, the results no longer show an increase in agricultural expenditures in year 2, but the impact on agricultural assets (though not total assets) is maintained. This result is consistent with a story where farmers are not making further investments in their farm in the second year, but have maintained the investments they made after receiving the transfer.

The results for nonagricultural consumption and expenditure show that the transfer led to a 10 percent increase in food expenditures in year 2. Interestingly, this result disappears when examining the per-capita consumption results. However, there is a positive result for food and total per-capita expenditure for the management plan group. These results indicate that the program may have has some effect on household composition and indeed regressions analyzing program

impacts on household size are suggestive of the increases in household size for the transfer size and decreases in household size for the management plan only group.

Finally it is important to examine whether increases in chemical fertilizer use are maintained from midline to endline. The results are presented in the bottom panel of Table 8. Chemical fertilizer use in the transfer group is nine percentage points higher than in the visits only group, a different that falls short of statistical significance. It is however, statistically different from fertilizer usage in the management plan group. It should be noted that fertilizer use went up overall in the second year, increasing by six percentage points in the visits only group, perhaps limiting the scope for continued impact in the transfer group. Despite suggestive evidence of an increase in fertilizer use, unlike in year 1, that increase does not seem to be attributable to any of the four main crops (Table 9).

VII. Conclusion

This paper examines the impacts of a graduation-style 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 and a large cash transfer from a group that received only monthly advisory visits. We find that the treatment that included the farm plan and the cash transfer led to large increases in crop production and sales and increases in livestock ownership after the first year. An exploration of mechanisms suggests that farmers are using the cash transfer to invest in their farm. This is supported by a demonstrated increase in the use of chemical fertilizer.

These results show that large, one-time, transfers aimed at agriculture can have a large impact on production, contrary to the results found in Ghana by Karlan et al. (2015). This

difference may be due to the support and guidance that accompanied the transfers. However, the sustained impacts that are necessary to the success of a program such as this are not clear; there is only a suggestive increase in agricultural production at endline. Nevertheless there is a sustained increase in the ownership of livestock and agricultural equipment, suggesting that farmers have made a lasting investment in their farms.

This project also contributes to the literature on financial training for small businesses by moving it to the agricultural sector. Overall there is little evidence that the management plan can be effective when not combined with the cash transfer. However, because all households received some level of business advice through the advisory visits, further research should further investigate this issue.

The results suggest that graduation programs aimed at agricultural production have the potential to be effective, but also that the transfers may be the most valuable components of these programs. Future research should continue to address the most important aspects of these programs. Given that the estimated impacts far exceeded the amount of the transfer in the first year, this program has the potential to be transformative for farmers and scalable for governments and NGOs across sub-Saharan Africa. However, the mixed evidence on the sustainability of these first-year impacts is a cautionary note for policy makers. Further research into the how to best design these programs to maximize impacts over time is needed.

References

Ambler, Kate, Alan de Brauw, and Susan Godlonton. 2016. "Relaxing Constraints for Family Farmers: Providing Capital and Information in Malawi," working paper.

Banerjee, Abhijit, Ester Duflo, Nathanael Goldberg, Dean Karlan, Robert Osei, William Parienté, Jeremy Shapiro, Bram Thuysbaert, and Christopher Udry. 2015. "A Multi-faceted Program Causes Lasting Progress for the Very Poor: Evidence from Six Countries," *Science* 348(6236).

Benhassine, Najy, Florencia Devoto, Esther Duflo, Pascaline Dupas, and Victor Pouliquen. 2015. "Turning a Shove into a Nudge? A 'Labeled Cash Transfer' for Education," *American Economic Journal: Economic* Policy, 40: 86-125.

Blattman, Christopher, Eric P. Green, Julian Jamison, M. Christian Lehman, and Jeannie Annan. 2016. "The Returns to Microenterprise Support among the Ultrapoor: A Field Experiment in Postwar Uganda," *American Economic Journal: Applied Economics 8(2): 35-64.*

Boone, Ryan, Katia Covarrubias, Benjamin Davis, and Paul Winters. 2013. "Cash transfer program and agricultural production: the case of Malawi," *Agricultural Economics,* 44(2013): 365-78.

Covarrubias, Katia, Benjamin Davis, and Paul Winters. 2012. "From Protection to Production: Productive Impacts of the Malawi Social Cash Transfer Scheme," *Journal of Development Effectiveness*, 4(1): 50-77.

De Mel, Suresh, David McKenzie, and Christopher Woodruff. 2008. "Returns to Capital in Microenterprises: Evidence from a Field Experiment," *The Quarterly Journal of Economics,* 123(4): 1329-1372.

De Mel, Suresh, David McKenzie, and Christopher Woodruff. 2012. "One-time Transfers of Cash or Capital Have Long-lasting Effects on Microenterprises in Sri Lanka," *Science*, 335(6071): 962-966.

De Mel, Suresh, David McKenzie, and Christopher Woodruff. 2013. "Business Training and Female Enterprise Start-up, Growth, and Dynamics: Experimental Evidence from Sri Lanka," *Journal of Development Economics,* 106: 199-210.

Deaton, Angus and Salman Zaidi. 2002. Guidelines for Constructing Consumption Aggregates for Welfare Analysis. World Bank. https://openknowledge.worldbank.org/handle/10986/14101

FAO. 2012. "Smallholders and Family Farmers." http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf

Fiszbein, Ariel, Norbert Schady, Francisco H. G. Ferreira, Margaret Grosh, Niall Kelleher, Pedro Olinto, and Emmanuel Skoufias. 2009. Conditional Cash Transfers: Reducing Present and Future Poverty. World Bank Policy Report 47603.

Gertler, Paul, Sebastian Martinez, and Marta Rubio-Codina. 2012. "Investing cash transfers to raise long-term living standards." *American Economic Journal: Applied Economics*, 4(1), 164-192.

Handa, Sudhanshu, David Seidenfeld, Benjamin Davis, Gelson Tembo, and the Zambia Cash Transfer Evaluation Team. 2015. "The Social and Productive Impacts of Zambia's Child Grant," *Journal of Policy Analysis and Management*, 00(0): 1-36.

Haushofer, Johannes and Jeremy Shapiro. 2016. "The Short-Term Impact of Unconditional Cash Transfers to the Poor: Evidence from Kenya." *The Quarterly Journal of Economics*, forthcoming.

Karlan, Dean, Robert Osei, Isaac Osei-Akoto, and Christopher Udry. 2014. "Agricultural Decisions after Relaxing Credit and Risk Constraints." *The Quarterly Journal of Economics*, 597-652

McKenzie, David and Christopher Woodruff. 2013. "What Are We Learning from Business Training and Entrepreneurship Evaluations are the Developing World?" *The World Bank Research Observer*, 29: 48-82.

McKenzie, David and Christopher Woodruff. 2015. "Business Practices in Small Firms in Developing Countries, World Bank Policy Research Working Paper 7405.

Perry, Henry, Rose Zulliger, and Michael M. Rogers. 2014. "Community Health Workers in Low-, Middle-, and High-Income Countries: An Overview of Their History, Recent Evolution, and Current Effectiveness," *Annual Review of Public Health*, 35: 399-421.

Veras Soares, Fabio, Rafael Perez Ribas, and Guilherme Issamu Hirata. 2010. "Impact evaluation of a rural conditional cash transfer programme on outcomes beyond health and education." *Journal of Development Effectiveness*, 2(1): 138-157.

Todd, Jessica Erin, Paul Winters, and Tom Hertz. 2010. "Conditional cash transfers and agricultural production: lessons from the Oportunidades experience in Mexico." *Journal of Development Studies*, 46 (1): 39–67.

Figure 1a: Villages by association

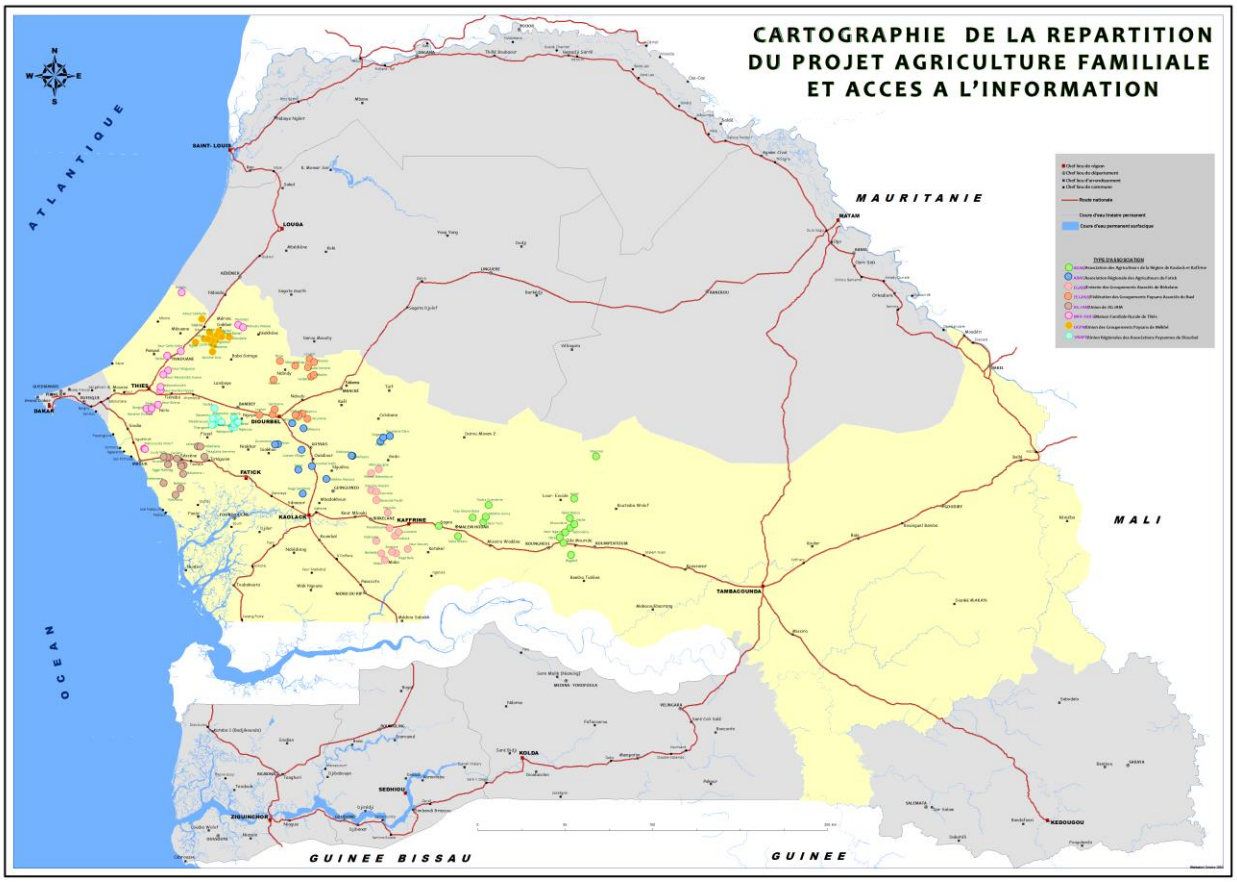

Figure 1b: Villages by treatment

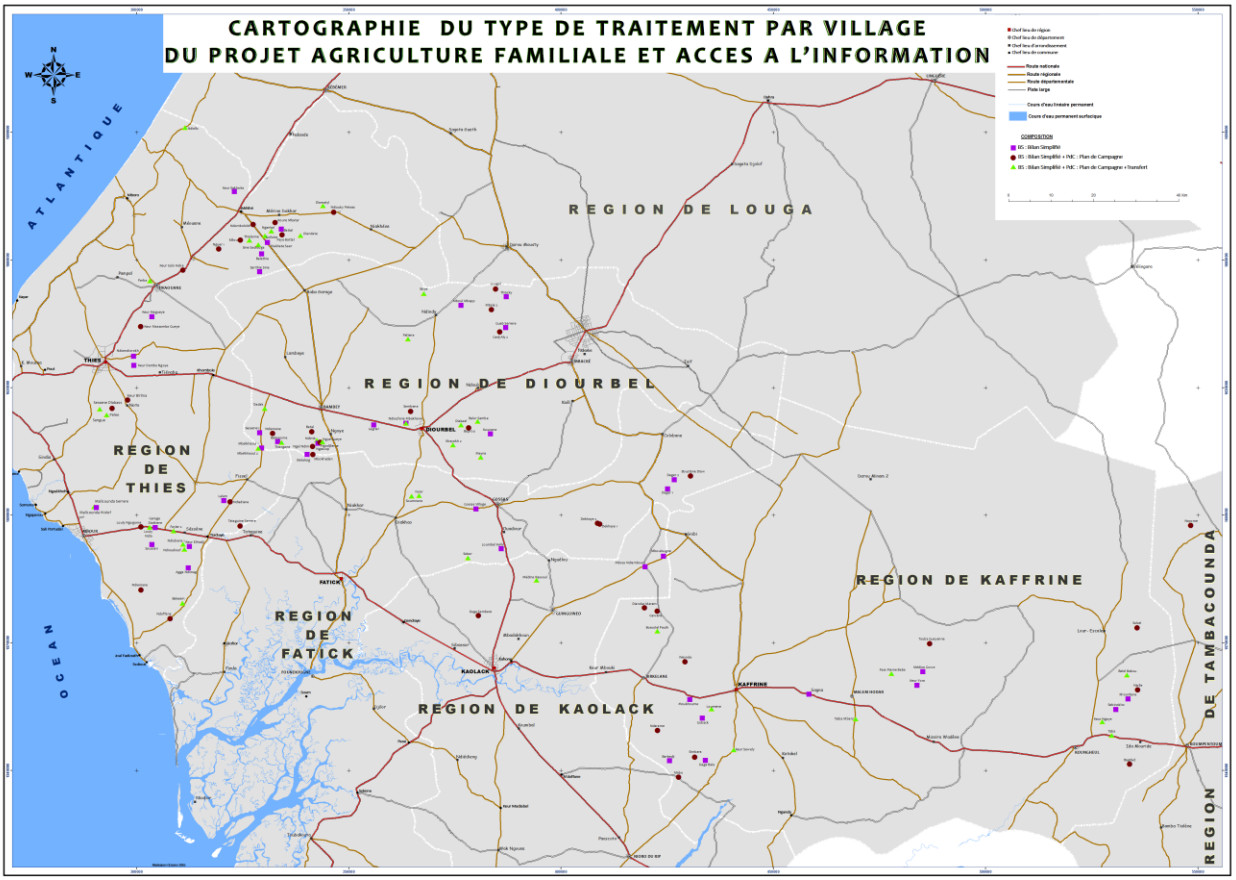

Figure 2: Project timeline

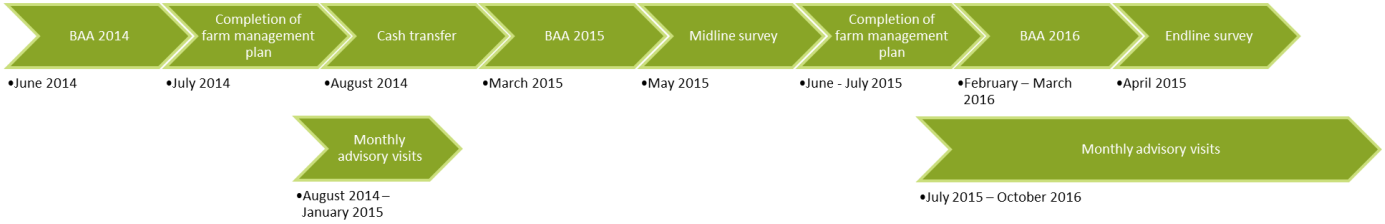

Figure 3: Reported use of cash transfer

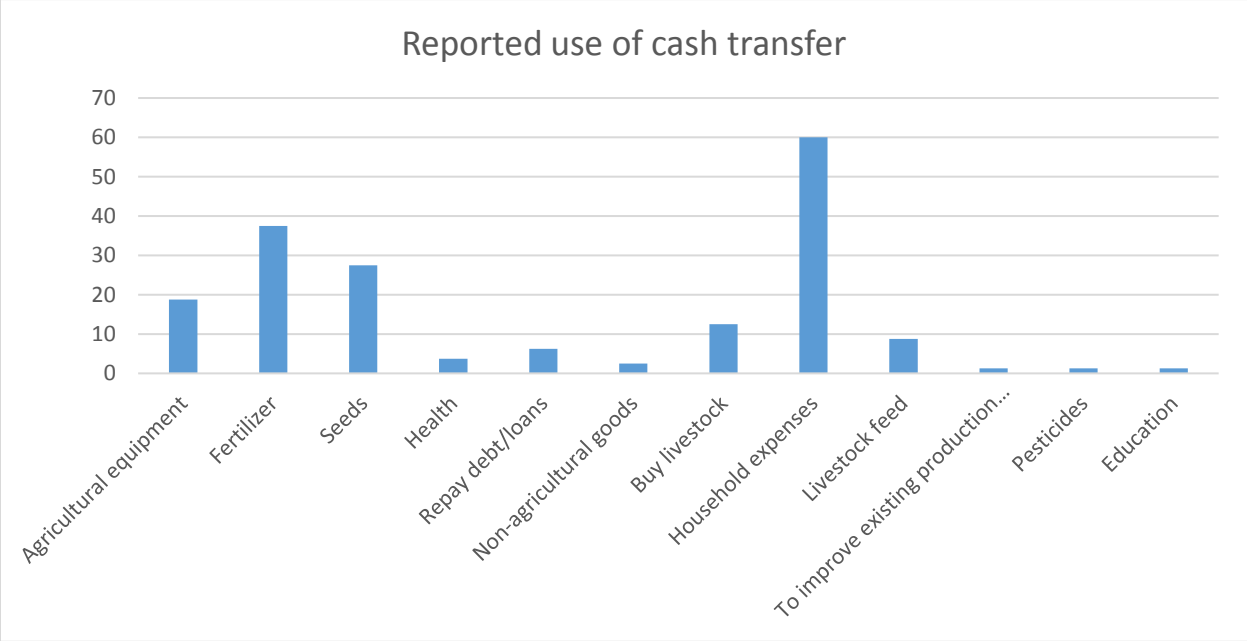

Table 1: Baseline balance by treatment: Midline survey sample

	BAA only	BAA + extension plan	BAA + extension 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 Head	52.2	51.2	53.7	0.643	0.455	0.229	0.472
HH Head is polygamous	0.35	0.41	0.51	0.454	0.044	0.206	0.127
HH 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
Number of adults in household	8.3	8.3	9.2	0.923	0.120	0.197	0.264
Number of children in household	8.8	7.8	9.0	0.212	0.900	0.156	0.268
Number of females in household	8.6	8.1	8.7	0.503	0.902	0.457	0.705
Number of males in household	8.5	8.0	9.5	0.462	0.199	0.040	0.119
Agricultural measures							
Total agricultural equipment value (USD)	1,381	1,604	1,832	0.436	0.078	0.516	0.189
Total land area (sum of crop areas) (ha)	7.6	8.3	8.2	0.479	0.570	0.884	0.748
Total land area rented and borrowed (ha)	1.6	1.9	1.7	0.538	0.724	0.748	0.826
Number of crops grown	3.3	3.2	3.1	0.334	0.304	0.932	0.532
Gross value of agricultural output (USD)	1,476	1,246	1,845	0.368	0.212	0.027	0.085
Total value of crops sold (USD)	644	508	923	0.371	0.174	0.025	0.078
Gross value of agricultural output per hectare (USD)	274	165	368	0.282	0.534	0.082	0.128
Total value of agricultural expenditures (USD)	607	633	721	0.813	0.304	0.455	0.573
Total value of livestock owned (USD)	2,408	1,936	2,544	0.458	0.841	0.256	0.488
Total value of own livestock consumed by household (USD)	163	95	159	0.044	0.933	0.074	0.045
Total value of livestock sales (USD)	298	242	373	0.484	0.400	0.070	0.190
Tropical livestock units	4.4	3.5	3.9	0.455	0.719	0.546	0.698

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

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 1=2
	1	2	3	4
Main household composition characteristics				
Household head is female	0.12	0.12	0.12	0.861
Age of Head	53.1	53.6	52.3	0.230
HH Head is polygamous	0.42	0.41	0.43	0.684
HH Head has at least some education	0.33	0.31	0.36	0.260
Household size	16.5	16.2	17.1	0.136
Number of adults in household	8.2	7.9	8.6	0.038
Number of children in household	8.4	8.3	8.5	0.515
Number of females in household	8.0	7.7	8.4	0.039
Number of males in household	8.6	8.5	8.7	0.512
Agricultural measures				
Total agricultural equipment value (USD)	1,511	1,447	1,607	0.257
Total land area (sum of crop areas) (ha)	8.5	8.8	8.0	0.319
Total land area rented and borrowed (ha)	1.7	1.6	1.7	0.735
Number of crops grown	3.2	3.2	3.2	0.771
Gross value of agricultural output (USD)	1,461	1,421	1,523	0.512
Total value of crops sold (USD)	625	581	692	0.249
Gross value of agricultural output per hectare (USD)	213	176	269	0.073
Total value of agricultural expenditures (USD)	584	538	654	0.039
Total value of livestock owned (USD)	2,271	2,254	2,295	0.925
Total value of own livestock consumed by household (USD)	128	120	139	0.329
Total value of livestock sales (USD)	307	309	304	0.953
Tropical livestock units	3.6	3.3	3.9	0.291

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

Table 3: Comparison of BAA and survey data for regression outcomes

	Midline			Endline		
	BAA	Survey	p-value for BAA=survey	BAA	Survey	p-value for BAA=survey
	1	2	3	4	5	6
Crop production						
Groundnuts (kg)	1,288	1,188	0.217	1,497	1,635	0.021
Millet (kg)	1,332	1,211	0.022	1,444	1,231	0.000
Sorghum (kg)	77	60	0.094	82	62	0.002
Maize (kg)	129	108	0.294	102	108	0.597
Manioc (kg)	62	10	0.006	27	34	0.327
Gross value of agricultural output (USD)	1,114	1,348	0.006	1,172	1,425	0.000
Value of agricultural production by hectare						
Groundnuts (USD)	148	173	0.063	192	309	0.095
Millet (USD)	171	161	0.492	136	173	0.364
All crops (USD)	163	162	0.918	164	229	0.042
Number of livestock owned						
Cows	3.7	3.3	0.202	3.5	3.3	0.449
Sheep	8.5	7.2	0.033	7.4	5.7	0.000
Goats	5.6	5.0	0.077	5.9	4.8	0.000
Poultry	14.2	12.9	0.146	12.9	9.3	0.000
Tropical livestock units	4.3	5.8	0.000	4.0	5.3	0.000
Total livestock value (USD)	2,229	2,657	0.013	2,105	2,512	0.000
Expenditures and investments						
Agriculture expenditures (USD)	471	340	0.000	456	349	0.000
Agriculture equipment value (USD)	1,216	326	0.000	1,195	464	0.000
Food and non-food consumption and expen	145	575	0.000	142	492	0.000

Notes: Values are from the BAA 2015 and Midline survey in columns 1 and 2 respectively. P-values are for a t-test that BAA 2015 and Midline values are equal.

Table 4: Treatment impact on crop production

	Production in kg of...					
	Groundnuts	Millet	Sorghum	Maize	Manioc	Gross value of agricultural output
	1	2	3	4	5	6
Midline BAA						
Household received management plan (Group 2)	-103.7	205.2	25.58	-6.733	-3.892	-22.33
	[155.1]	[142.9]	[16.43]	[33.89]	[22.58]	[108.3]
Household received management plan and cash transfer (Group 3)	144.8	503.0***	17.67	63.54*	-21.82	404.2***
	[176.9]	[158.4]	[15.97]	[32.61]	[19.47]	[138.5]
Observations	600	600	600	600	600	600
R-squared	0.669	0.492	0.436	0.553	0.505	0.551
Control mean	1,406.8	1,210.7	52.2	112.1	46.9	1,033.4
P-value for equality of coefficients: Group 2 = Group 3	0.060	0.032	0.634	0.012	0.440	0.000
Midline survey						
Household received management plan (Group 2)	380.9	252.3	8.162	40.66	-19.71	408.4*
	[258.4]	[169.9]	[15.26]	[32.78]	[14.83]	[242.9]
Household received management plan and cash transfer (Group 3)	258.3	279.2*	13.87	84.71**	-19.45	556.7**
	[184.1]	[160.4]	[19.90]	[35.15]	[13.48]	[210.1]
Observations	239	239	239	239	239	239
R-squared	0.700	0.461	0.420	0.668	0.304	0.576
Control mean	923.9	990.3	46.7	79.0	20.0	973.1
P-value for equality of coefficients: Group 2 = Group 3	0.635	0.883	0.777	0.092	0.967	0.546
Endline BAA						
Household received management plan (Group 2)	40.33	116.1	-40.75	73.74**	63.38***	119.4
	[150.0]	[126.3]	[25.62]	[28.17]	[23.57]	[75.13]
Household received management plan and cash transfer (Group 3)	121.5	107.7	-22.99	71.74**	37.29	186.4**
	[155.3]	[143.5]	[28.22]	[32.44]	[25.58]	[88.23]
Observations	599	599	599	599	599	599
R-squared	0.579	0.491	0.318	0.496	0.319	0.582
Control mean	1,534.7	1,396.0	100.7	64.1	6.7	1,081.9
P-value for equality of coefficients: Group 2 = Group 3	0.637	0.950	0.430	0.941	0.425	0.435
Endline survey						
Household received management plan (Group 2)	131.9	38.03	-38.76**	17.55	2.704	-12.2
	[241.0]	[86.65]	[15.78]	[23.11]	[11.35]	[133.4]
Household received management plan and cash transfer (Group 3)	-164.4	56.03	-22.16	40.83	0.992	66.05
	[184.0]	[96.12]	[15.79]	[26.93]	[12.00]	[132.8]
Observations	598	598	598	598	598	598
R-squared	0.533	0.448	0.349	0.497	0.386	0.437
Control mean	1,766.0	1,218.0	80.4	100.9	24.1	1,417.0
P-value for equality of coefficients: Group 2 = Group 3	0.142	0.852	0.196	0.342	0.902	0.519
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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Treatment impact on value yields

	Crop value per ha…		
	Groundnuts	Millet	GVAO per ha
	1	2	6
Midline BAA			
Household received management plan (Group 2)	6.554	-12.07	-6.393
	[16.18]	[21.53]	[16.51]
Household received management plan and cash transfer (Group 3)	33.94*	25.71	55.87**
	[19.12]	[24.44]	[23.03]
Observations	547	569	598
R-squared	0.244	0.171	0.737
Control mean	141.1	160.1	144.3
P-value for equality of coefficients: Group 2 = Group 3	0.059	0.009	0.001
Midline survey			
Household received management plan (Group 2)	-14.49	0.953	-2.954
	[32.00]	[20.41]	[21.54]
Household received management plan and cash transfer (Group 3)	13.33	35.12	48.52*
	[30.83]	[26.17]	[25.68]
Observations	218	214	238
R-squared	0.231	0.214	0.459
Control mean	169.3	140.8	137.6
P-value for equality of coefficients: Group 2 = Group 3	0.424	0.185	0.110
Endline BAA			
Household received management plan (Group 2)	24.64	7.219	18.83
	[16.72]	[11.15]	[11.81]
Household received management plan and cash transfer (Group 3)	17.66	-4.016	33.47**
	[17.21]	[10.80]	[16.71]
Observations	550	561	595
R-squared	0.171	0.275	0.445
Control mean	173.6	132.6	143.3
P-value for equality of coefficients: Group 2 = Group 3	0.714	0.292	0.413
Endline survey			
Household received management plan (Group 2)	-69.76	158	92.76
	[199.9]	[151.6]	[96.77]
Household received management plan and cash transfer (Group 3)	-149.9	3.989	29.02
	[130.9]	[47.54]	[34.76]
Observations	552	569	594
R-squared	0.041	0.052	0.071
Control mean	401.6	132.9	191.2
P-value for equality of coefficients: Group 2 = Group 3	0.535	0.301	0.522
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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Table 6: 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 BAA								
Household received management plan (Group 2)	0.0548	-0.013	-0.149	-2.242			0.0663	-177.1
	[0.333]	[0.749]	[0.407]	[1.512]			[0.295]	[318.5]
Household received management plan and cash transfer (Group 3)	0.16	0.167	-0.0926	1.008			0.193	61.33
	[0.338]	[0.584]	[0.456]	[1.513]			[0.295]	[243.6]
Observations	600	600	600	600			600	600
R-squared	0.778	0.756	0.581	0.360			0.779	0.608
Control mean	3.9	8.7	5.3	12.7			4.3	2,272.7
P-value for equality of coefficients: Group 2 = Group 3	0.786	0.795	0.910	0.031			0.712	0.483
Midline survey								
Household received management plan (Group 2)	0.288	-0.0409	-0.381	-0.0204	0.0565	0.0281	0.353	233.1
	[0.742]	[1.402]	[0.704]	[1.708]	[0.247]	[0.206]	[0.658]	[464.6]
Household received management plan and cash transfer (Group 3)	1.059**	1.94	1.001	3.999**	-0.273	0.659***	1.491***	825.5**
	[0.515]	[1.180]	[0.629]	[1.644]	[0.221]	[0.217]	[0.514]	[348.5]
Observations	239	239	239	239	239	239	239	239
R-squared	0.589	0.500	0.493	0.214	0.272	0.312	0.622	0.500
Control mean	2.9	6.5	4.4	11.1	1.6	1.4	5.2	2,290.0
P-value for equality of coefficients: Group 2 = Group 3	0.249	0.034	0.019	0.044	0.119	0.008	0.050	0.186
Endline BAA								
Household received management plan (Group 2)	0.881*	1.414	-0.162	1.033			0.858*	385.7
	[0.469]	[1.018]	[0.700]	[1.691]			[0.438]	[276.3]
Household received management plan and cash transfer (Group 3)	0.669	0.784	0.121	0.641			0.697*	393.4
	[0.439]	[0.887]	[0.818]	[1.495]			[0.399]	[337.5]
Observations	599	599	599	599			599	599
R-squared	0.648	0.603	0.338	0.197			0.654	0.546
Control mean	3.5	7.6	5.9	12.1			4.0	2,037.5
P-value for equality of coefficients: Group 2 = Group 3	0.594	0.510	0.710	0.821			0.672	0.981
Endline survey								
Household received management plan (Group 2)	0.763	0.74	0.930*	-0.614	0.114	-0.0686	0.826	356
	[0.595]	[0.544]	[0.471]	[1.063]	[0.139]	[0.129]	[0.523]	[301.5]
Household received management plan and cash transfer (Group 3)	0.909	1.069**	1.588***	0.266	-0.0144	0.175	1.185*	733.2**
	[0.722]	[0.521]	[0.548]	[1.068]	[0.148]	[0.132]	[0.625]	[308.1]
Observations	598	598	598	598	598	598	598	598
R-squared	0.441	0.493	0.430	0.143	0.164	0.295	0.477	0.453
Control mean	3.1	5.3	4.0	8.9	1.2	1.4	5.0	2,332.0
P-value for equality of coefficients: Group 2 = Group 3	0.860	0.590	0.264	0.421	0.332	0.045	0.623	0.303
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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Treatment impact on investment, consumption, and expenditures

	Agriculture expenditures	Agriculture equipment value	Non agricultural assets value	Total assets value	Household monthly consumption and expenditure			Per-capita monthly consumption and expenditure		
					Total	Food	Non-food	Total	Food	Non-food
	1	2	3	4	5	6	7	8	9	10
Midline survey										
Household received management plan (Group 2)	-1.942	10.84	194.9	215.2	-16.46	-7.681	-6.614	-0.439	-0.354	-0.123
	[39.88]	[27.06]	[167.8]	[188.9]	[55.29]	[28.46]	[30.25]	[3.747]	[1.875]	[1.827]
Household received management plan and cash transfer (Group 3)	106.0**	92.40*	149.6	264.7*	84.32	13.42	59.92*	2.982	0.109	2.78
	[43.86]	[46.32]	[140.1]	[156.1]	[59.43]	[32.89]	[32.33]	[3.920]	[2.123]	[1.887]
Observations	239	239	239	239	239	239	239	239	239	239
R-squared	0.408	0.356	0.291	0.317	0.289	0.395	0.193	0.275	0.432	0.134
Control mean	290.4	273.7	933.8	1,208.1	560.3	324.6	234.1	34.9	20.1	14.4
P-value for equality of coefficients: Group 2 = Group 3	0.052	0.120	0.799	0.816	0.120	0.513	0.074	0.369	0.815	0.153
Endline survey										
Household received management plan (Group 2)	-28.36	25.87	104.7	115.1	16.05	16.54	-0.734	3.359*	2.445***	1.029
	[30.17]	[23.78]	[152.3]	[179.5]	[26.63]	[11.54]	[15.73]	[1.784]	[0.931]	[1.056]
Household received management plan and cash transfer (Group 3)	-2.792	73.99**	6.036	69.78	8.63	24.79**	-13.17	-0.454	0.845	-1.244
	[37.34]	[33.22]	[142.7]	[161.6]	[25.98]	[12.34]	[14.83]	[1.446]	[0.773]	[0.888]
Observations	598	598	598	598	598	598	598	598	598	598
R-squared	0.375	0.448	0.241	0.249	0.326	0.348	0.260	0.306	0.316	0.224
Control mean	361.6	445.2	1,065.9	1,520.6	473.1	254.3	215.1	30.6	16.7	13.9
P-value for equality of coefficients: Group 2 = Group 3	0.480	0.137	0.428	0.768	0.772	0.530	0.390	0.020	0.076	0.014
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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Table 8: 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)	-0.0402	-36.92	0.0143	-0.133*
	[0.0664]	[45.67]	[0.0715]	[0.0715]
Household received management plan and cash transfer (Group 3)	0.169**	101.7	-0.0328	-0.0954
	[0.0831]	[63.49]	[0.0801]	[0.0733]
Observations	239	239	239	239
R-squared	0.234	0.264	0.161	0.278
Control mean	0.4	165.9	0.7	0.9
P-value for equality of coefficients: Group 2 = Group 3	0.024	0.020	0.606	0.679
Endline survey				
Household received management plan (Group 2)	-0.0193	-34.46	-0.00939	-0.0123
	[0.0628]	[30.96]	[0.0449]	[0.0419]
Household received management plan and cash transfer (Group 3)	0.0953	4.949	0.0355	0.0206
	[0.0603]	[30.60]	[0.0425]	[0.0404]
Observations	598	598	598	598
R-squared	0.204	0.290	0.180	0.244
Control mean	0.5	187.3	0.8	0.9
P-value for equality of coefficients: Group 2 = Group 3	0.044	0.185	0.265	0.435
Includes baseline value of outcome	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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Table 9: Treatment impact on chemical fertilizer use by crop

	Used any chemical fertilizer on…				*Amount of chemical fertilizer (kg) used on…*			
	Groundnuts	Millet	Sorghum	Maize	Groundnuts	Millet	Sorghum	Maize
	1	2	3	4	5	6	7	8
Midline survey								
Household received management plan (Group 2)	-0.0156	0.0161	-0.0265	-0.0108	-13.53	-4.21	-7.539	2.815
	[0.0630]	[0.0680]	[0.0420]	[0.0415]	[20.99]	[21.76]	[5.727]	[7.253]
Household received management plan and cash transfer (Group 3)	0.135**	0.192**	0.0363	0.0745	11.55	28.08	-4.076	13.7
	[0.0665]	[0.0868]	[0.0575]	[0.0513]	[20.27]	[25.26]	[7.287]	[9.388]
Observations	239	239	239	239	239	239	239	239
R-squared	0.159	0.308	0.179	0.357	0.153	0.281	0.205	0.292
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	0.054	0.053	0.201	0.091	0.198	0.152	0.483	0.176
Endline survey								
Household received management plan (Group 2)	-0.0751	-0.0595	-0.0359*	0.0114	-21.01	1.328	-4.665**	-4.001
	[0.0472]	[0.0617]	[0.0215]	[0.0331]	[14.77]	[14.77]	[2.062]	[6.290]
Household received management plan and cash transfer (Group 3)	-0.0153	0.0046	-0.0268	0.0183	-18.4	6.732	-4.075*	3.367
	[0.0479]	[0.0575]	[0.0254]	[0.0274]	[12.11]	[14.60]	[2.373]	[6.503]
Observations	598	598	598	598	598	598	598	598
R-squared	0.156	0.212	0.103	0.294	0.225	0.262	0.099	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	0.174	0.214	0.562	0.820	0.818	0.682	0.632	0.270
Includes baseline value of outcome	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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 1: Baseline balance by treatment: Full sample

	BAA only	BAA + extension plan	BAA + extension 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 Head	53.0	52.0	54.4	0.427	0.257	0.062	0.167
HH Head is polygamous	0.39	0.42	0.44	0.542	0.311	0.687	0.594
HH 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
Number of adults in household	8.3	7.7	8.6	0.107	0.551	0.034	0.087
Number of children in household	8.7	7.7	8.7	0.046	0.960	0.046	0.064
Number of females in household	8.3	7.4	8.3	0.028	0.925	0.042	0.048
Number of males in household	8.7	8.0	9.0	0.100	0.566	0.024	0.059
Agricultural measures							
Total agricultural equipment value (USD)	1,552	1,513	1,468	0.810	0.529	0.795	0.820
Total land area (sum of crop areas) (ha)	8.9	8.8	7.7	0.938	0.058	0.345	0.139
Total land area rented and borrowed (ha)	2.2	1.4	1.4	0.016	0.007	0.815	0.020
Number of crops grown	3.3	3.1	3.2	0.025	0.172	0.350	0.081
Gross value of agricultural output (USD)	1,520	1,415	1,450	0.618	0.703	0.846	0.877
Total value of crops sold (USD)	634	651	591	0.886	0.705	0.592	0.855
Gross value of agricultural output per hectare (USD)	212	171	256	0.315	0.472	0.074	0.133
Total value of agricultural expenditures (USD)	604	560	589	0.523	0.814	0.661	0.811
Total value of livestock owned (USD)	2,650	2,160	2,003	0.470	0.261	0.736	0.525
Total value of own livestock consumed by household (USD)	154	100	128	0.014	0.293	0.182	0.043
Total value of livestock sales (USD)	297	354	269	0.632	0.590	0.463	0.699
Tropical livestock units	4.2	3.2	3.4	0.182	0.246	0.715	0.386

Notes: All values are from the BAA 2014.

Appendix Table 2: Treatment impact on crop sales

	Production in kg of…					
	Groundnuts	Millet	Sorghum	Maize	Manioc	Gross value of agricultural output
	1	2	3	4	5	6
Midline BAA						
Household received management plan (Group 2)	-80.05	86.88*	17.51***	28.40**	-7.277	-2.24
	[141.3]	[48.39]	[6.389]	[12.68]	[21.09]	[61.93]
Household received management plan and cash transfer (Group 3)	69.25	149.5***	7.25	33.13***	-30.37*	182.2**
	[151.9]	[49.58]	[5.002]	[10.29]	[16.94]	[79.48]
Observations	600	600	600	600	600	600
R-squared	0.653	0.272	0.283	0.419	0.478	0.595
Control mean	993.4	79.1	3.3	10.0	41.3	424.7
P-value for equality of coefficients: Group 2 = Group 3	0.181	0.266	0.128	0.658	0.204	0.012
Midline survey						
Household received management plan (Group 2)	333.9*	122.0*	0.162	6.422	-21.14	226.7
	[195.0]	[64.05]	[5.138]	[6.383]	[15.39]	[139.2]
Household received management plan and cash transfer (Group 3)	187.9	47.33	5.767	-2.809	-22.54	211.2*
	[136.8]	[58.07]	[7.525]	[5.547]	[13.62]	[105.7]
Observations	239	239	239	239	239	239
R-squared	0.714	0.165	0.202	0.103	0.310	0.609
Control mean	623.2	72.3	8.7	7.5	20.0	413.6
P-value for equality of coefficients: Group 2 = Group 3	0.445	0.312	0.318	0.121	0.821	0.913
Endline BAA						
Household received management plan (Group 2)	17.63	67.07	-11.27	45.22***	55.48**	23.16
	[133.9]	[70.85]	[14.36]	[12.88]	[21.34]	[69.48]
Household received management plan and cash transfer (Group 3)	76	11.94	-20.16	32.72*	32.74	75.98
	[138.5]	[78.76]	[16.74]	[19.51]	[22.59]	[69.77]
Observations	599	599	599	599	599	599
R-squared	0.566	0.137	0.116	0.261	0.341	0.520
Control mean	1,076.2	147.2	28.7	4.0	6.5	517.3
P-value for equality of coefficients: Group 2 = Group 3	0.704	0.431	0.285	0.484	0.428	0.489
Endline survey						
Household received management plan (Group 2)	99.31	10.31	-7.093	3.95	-1.044	14.33
	[187.5]	[29.95]	[4.529]	[3.435]	[10.53]	[90.33]
Household received management plan and cash transfer (Group 3)	-179.9	-36.57*	-6.665	8.564**	-0.152	-33.79
	[138.2]	[19.41]	[4.470]	[4.169]	[11.15]	[77.09]
Observations	598	598	598	598	598	598
R-squared	0.495	0.138	0.093	0.150	0.388	0.404
Control mean	1,167.1	84.1	12.5	6.1	23.0	607.8
P-value for equality of coefficients: Group 2 = Group 3	0.074	0.087	0.889	0.220	0.946	0.549
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 the household head's education level. All regressions include the baseline value of outcome and association (BAA) or enumerator (survey) fixed effects.

*** p<0.01, ** p<0.05, * p<0.1