Impact Evaluation of Smallholders Agriculture Productivity Enhancement and Commercialization (SAPEC)

ENDLINE SURVEY REPORT

Development Impact Evaluation (DIME)
Smallholders Agriculture Productivity Enhancement and Commercialization (SAPEC)

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GAFSP
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1 Introduction

This report presents the main ndings of the endline household survey for Impact Evaluation of the Smallholder Agriculture Productivity Enhancement and Commercialization (SAPEC) project. The endline survey was implemented from November to December 2018. The report provides descriptive statistics on the following topics: socioeconomic pro le of the households, agriculture production and commercialization, household income, and food security. Furthermore, this report describes the changes in household income and production from baseline to endline.

2 Background

The Smallholder Agricultural Productivity Enhancement and Commercialization Project (SAPEC) was established as a cornerstone of the Liberia Agriculture Sector Investment Program (LASIP) to increase yields and improve nutritional outcomes in bene ciary communities. [1] SAPEC has four pillars: sustainable crop production intensi cation, value addition and marketing, capacity building and institutional strengthening; and project management. The sustainable crop production intensi cation pillar includes the development of lowland rice for production and the dissemination of improved agricultural technologies to farmers. The increased yields resulting from this strategy should improve the nutritional outcomes of farmers in the bene ciary group. The second and third pillars of SAPEC correspond to the activities related to the creation/encouragement of the value chains and improvements in Liberia's agricultural research and instructional capacity.

The component reaching the largest number of farmers involves the subsidized distribution of agricultural tools and vegetable seeds to farmers in twelve of Liberia's fteen counties. These activities are evaluated through a randomized control trial at the community and household level to rigorously test the impact of these activities.

SAPEC also supported the creation of farmers in a nationwide e-registration database which was used as a platform for delivering improved varieties of rice and cassava through private agro-dealers as part of a program called the Liberia Agricultural Transformation Agenda (LATA). The impact evaluation of the input distribution was conducted among farmers registered for the e-registration system. The report includes descriptive evidence on which farmers received and redeemed vouchers for these improved varieties.

[1] SAPEC is nanced by the Global Agriculture and Food Security Program (GAFSP) and implemented by the Ministry of Agriculture with supervision by the African Development Bank. Funding for the impact evaluation was provided by the GAFSP and with UK aid from the UK government.

Finally, SAPEC's activities included the establishment of cassava processing centers and road construction. Since these activities were in limited areas, they are also not part of the randomized control trial, but the sample includes farmers involved in the cassava processing centers in order to provide further information on the farmers most affected by these activities.

2.1 Impact Evaluation (IE) of Farm Tools Distribution Program

The most common reason cited by farmers for not using modern inputs and methods is a lack of access to materials. This suggests that constraints to agriculture productivity in Liberia are necessary materials to practice high value agriculture and a lack of awareness among farmers at the local level that these methods are effective. In order to address these constraints, a package of inputs that are necessary to practice modernized farming were distributed to farmers. In the package are poultry manure, cutlass, file, axe, trap wire, flash tape, hoe, fertilizers, cassava cuttings, project. Throughout the lifespan of the project, the collection and management of the household data wa Tdaao

Farmers in the sampling frame were selected on a criteria based on three key components: the farmer had to be in the e-registration platform, the farmer had to have land to cultivate crops (farmer must have cultivated crops on his/her land in the past year), and the farmer had to be either a rice or cassava farmer. A priority list of households was developed from this frame and these farmers were randomly selected. The priority farmers would be targeted first before finding replacement farmers if the priority farmer could not be interviewed. This process was conducted for both farmers that received the package of farm tools through the inputs distribution program and those that received the farm tools through private agro-dealers.

Although, the survey team was provided with all the farmers interviewed during baseline, there was some difficulty in locating them. A considerable proportion of households interviewed during baseline could not be received through the mobile number they provided and some had moved to another village or community from the one listed on the registration list. Similarly, a small portion of farmers had to be replaced during endline as a result of some of the difficulties mentioned above.

3.3 Endline household survey

The Center for Evaluation and Development (C4ED) in coordination with its local partner The Khana Group (TKG) implemented the endline survey from November to December 2018. The survey was conducted on android tablets using SurveyCTO - a data collection software which allowed the data to be submitted electronically. The survey focused on agricultural production and food security, and contained modules on housing, labor, education, food security, income, expenditures, personality traits, and assets.

The IE sample includes 12 of Liberia's counties and across 97 communities.[2] In treatment communities, 10-11 farmers were randomly selected to receive the package of farm tools while another 2 farmers were randomly chosen to not receive the package of farm tools during the 2017 round of distribution in order to create an internal control group. Randomization was done at the community level for which communities would receive the package of farm tools benefits then randomly chosen at the farmer level. In control communities, the input distribution field teams were instructed not to distribute subsidized tools or seeds until after the endline survey was completed to allow the IE to compare equivalent populations who received or did not receive these inputs.

Table 1 shows the distribution of the sample across counties, separated into external control, farm tools treatment and farm tools control.

[2] The original design called for 100 communities to be included in the sample. However, the sample frame for three communities included less than the target number of households, and these three communities were dropped.

Table 1: SAPEC Endline Sample - County

County	External Control	Input Recipient	Non-Input Recipient	Total
Bomi	87	71	53	211
Gbarpolu	17	17	8	42
Grand Bassa	11	10	10	31
Grand Cape Mount	20	15	25	60
Grand Gedeh	51	22	25	98
Grand Kru	51	49	14	114
Margibi	13	10	3	26
Maryland	43	42	11	96
Monsterrado	63	70	58	191
River Cess	8	5	15	28
River Gee	34	24	28	86
Sinoe	51	16	22	89
Total	449	351	272	1072

In addition to the 1116 households that were interviewed at baseline, around 218 were added for the purpose of examining the e-registration platform on redeeming inputs through private agro-dealers. These 218 farmers were not interviewed during baseline and thus were not included in most of the descriptive statistics or analysis. About 70% or 739 endline households were interviewed at baseline, meaning the attrition attrition rate from baseline to endline was 30%. The primary reasons for attrition were households either migrating from the locations of residence at baseline or not being reachable by mobile phone numbers collected at baseline. This unusually high attrition rate was not statistically di erent across treatment groups in the RCT, and may have been explained by the disruption associated with the ebola crisis in Liberia that began in 2014, and subsidided only brie y before the endline.

3.4 Validity of control group

The IE sample includes 50 treatment communities and 47 control communities.[3] Within treatment communities, there are farmers selected to not directly receive the subsized inputs themselves. As a result, there are two types of \control" farmers. There are 10 control farmers from each of the control communities, which we refer to in this report as the \external control" farmers. The

[3] As noted earlier, the evaluation design originally planned to include 100 communities, evenly divided between treatment and control.

\control" farmers and their households who live in treatment communities but not receiving inputs during the study are referred to as input distribution community control farmers or non-input recipients in input distribution communities. We therefore report two types of treatment e ects in this report. The rst are community average treatment e ects pooling the sample of all households in communities enrolled in treatment. The interpretation of these treatment e ects are the impact of subsidized input provision on a group of registered farmers among whom 80% are targeted for inputs compared to a group of registered farmers amoung whom no farmers are targeted towards inputs. The second type of analysis separates the impacts of directly treated and indirectly treated farmers in treated communities.

Table 2: Balance Test - Sample of Baseline Households

	(1)		(2)		(3)		(4)			T-test	
	External Control		Input Recipient		Non-Input Recipient		Total			Di erence	
Variable	N	Mean/SE	N	Mean/SE	N	Mean/SE	N	Mean/SE	(1)-(2)	(1)-(3)	(2)-(3)
Upland Rice	479	0.610 (0.022)	525	0.575 (0.022)	112	0.518 (0.047)	1116	0.584 (0.015)	0.034	0.092*	0.057
Lowland Rice	479	0.294 (0.021)	525	0.322 (0.020)	112	0.232 (0.040)	1116	0.301 (0.014)	-0.028	0.062	0.090*
Cassava	479	0.656 (0.022)	525	0.630 (0.021)	112	0.670 (0.045)	1116	0.645 (0.014)	0.025	-0.014	-0.039
Improved Upland Rice	479	0.424 (0.023)	525	0.392 (0.021)	112	0.366 (0.046)	1116	0.403 (0.015)	0.031	0.058	0.026
Improved Lowland Rice	479	0.200 (0.018)	525	0.251 (0.019)	112	0.152 (0.034)	1116	0.220 (0.012)	-0.051*	0.049	0.100**
Improved Cassava	479	0.422 (0.023)	525	0.425 (0.022)	112	0.411 (0.047)	1116	0.422 (0.015)	-0.003	0.011	0.014
Gender of Household head	479	0.645 (0.022)	525	0.653 (0.021)	112	0.634 (0.046)	1116	0.648 (0.014)	-0.008	0.011	0.019
Age of Household head	470	45.521 (0.601)	514	44.377 (0.548)	112	43.232 (1.166)	1096	44.751 (0.383)	1.144	2.289*	1.145
Household size	479	3.971 (0.093)	525	3.785 (0.086)	112	3.589 (0.186)	1116	3.845 (0.060)	0.186	0.381*	0.195
Completed Primary School or less	279	0.441 (0.030)	299	0.388 (0.028)	63	0.381 (0.062)	641	0.410 (0.019)	0.053	0.060	0.007
Completed Secondary School or more	279	0.713 (0.027)	299	0.739 (0.025)	63	0.730 (0.056)	641	0.727 (0.018)	-0.026	-0.017	0.009
Gender of Person Resp. for Farming	479	0.628 (0.022)	525	0.640 (0.021)	112	0.661 (0.045)	1116	0.637 (0.014)	-0.012	-0.032	-0.021
Age of Person Resp. for Farming	470	45.345 (0.600)	514	44.424 (0.555)	112	43.214 (1.167)	1096	44.695 (0.385)	0.921	2.130	1.210
Completed Primary School - Person Resp. for Farming	279	0.441 (0.030)	299	0.388 (0.028)	63	0.381 (0.062)	641	0.410 (0.019)	0.053	0.060	0.007
Secondary Primary School - Person Resp. for Farming	279	0.713 (0.027)	299	0.739 (0.025)	63	0.730 (0.056)	641	0.727 (0.018)	-0.026	-0.017	0.009
Total farm income	479	320.016 (27.239)	525	303.045 (38.593)	112	333.280 (60.709)	1116	313.364 (22.422)	16.971	-13.264	-30.234
Total non-farm income	479	75.639 (8.765)	525	91.576 (12.059)	112	96.546 (23.088)	1116	85.234 (7.189)	-15.937	-20.906	-4.970
F-test of joint signi cance (F-stat)									0.664	1.368	1.090
F-test, number of observations									572	341	357

Notes: The value displayed for t-tests are the di erences in the means across the groups. The value displayed for F-tests are the F-statistics. ***, **, and * indicate signi cance at the 1, 5, and 10 percent critical level.

A standard way to demonstrate the validity of randomization in creating a rigorous counterfactual is to compare characteristics of treatment and control groups along a range of indicators measured at the baseline. Because neither group has started receiving the inputs at baseline, the treatment and control groups should be the same on average when comparing common household characteristics. Table 2 compares values of key indicators in treatment and both control groups (control communities and non-selected farmers within communities). As demonstrated by the F-tests at the bottom of the table, the small differences between the groups on 1-3 variables are no greater than would be expected from the two samples drawn from identical populations, supporting the validity of comparing the treatment and control group to measure the impact of the program.

3.5 Treatment Compliance

In addition to balance of observable characteristics, the other factor used to assess the validity of an RCT is compliance with treatment. Comparing outcomes for treatment and control farmers measures the impact of the program as long as those assigned to receive the treatment are more likely to receive inputs from the project than those assigned to the control group. Table 3 displays the treatment compliance figures across the three different treatment groups from baseline to endline as reported by SAPEC extension workers. According to SAPEC extension workers, treatment compliance on the input distribution was very high for the control group, as only one household assigned to not recieve the inputs was reported to have received them. Since only the inputs were randomized and not the extension visits, many people in both treatment and control groups were visited by SAPEC extension workers. Adherence with treatment among the treated group, however

Table 3: Treatment Compliance: Distribution list

	External Control		Input Recipient		Non-Input Recipient	
	Baseline N (%)	Endline N (%)	Baseline N (%)	Endline N (%)	Baseline N (%)	Endline N (%)
SAPEC worker visited	97	226	131	289	18	159
	(20.25)	(50.33)	(24.95)	(82.34)	(16.07)	(58.46)
SAPEC tools/inputs were recieved	0	0	369	269	0	1
	(0)	(0)	(70.29)	(76.64)	(0.00)	(0.37)
N	479	449	525	351	112	272

Numbers in parenthesis are column percentages

The gures displayed are obtained from the SAPEC distribution list

Table 4 compares the response from households in the endline indicating whether they agree that they received inputs/tools compared to the distribution list of households that received the inputs directly by SAPEC extension workers above. As one can see there is non-compliance with regards to who received the package of farm tools and inputs. Approximately, 17% of endline households who were reported by SAPEC extension workers reported as having been delivered inputs stated they did not receive inputs when interviewed at endline. Additionally, 29% of households who were reported by SAPEC extension workers as not having received any inputs from the eld teams reported in the endline survey that they *did* receive the farm tools and inputs. It is possible that these households received bene ts from another program and mis-attributed these bene ts to the inputs distribution program. Because it is not the case that 100% of treatment farmers received bene ts compared to 0% of control farmers as would be the case in the ideal experiment, the household reports further support the point that inputs should be interpreted as intent to treat impacts. However, because the randomized assignment of treatment did lead to large di erences in the proportion of farmers who received subsidized inputs, the RCT allows us to rigorously estimate the impact of the input distribution activities.

Shown in gure 2 are the lists of inputs/tools distributed by the input distribution eld teams and the percentage of households that received them by treatment status. The package of tools received varies considerably with di erent farmers in the treatment group receiving di erent tools. Therefore, the impact of the program is the impact of receiving any subsized tools from the program rather than the impact of receiving any speci c input. In addition to the tools shown below, most of the farmers who received inputs were also given vegetable seeds and some packages included manure to be used as organic fertilizer.

Table 4: SAPEC Inputs Received

	SAPEC Distribution List	
	Did Not Receive Inputs	Recieved Inputs
	N	N
	(%)	(%)
Recieved Inputs - endline response	217	210
	(29.93)	(82.35)
Did Not Recieve Inputs - endline response	508	45
	(70.07)	(17.65)
N	725	255

Numbers in parenthesis are column percentages

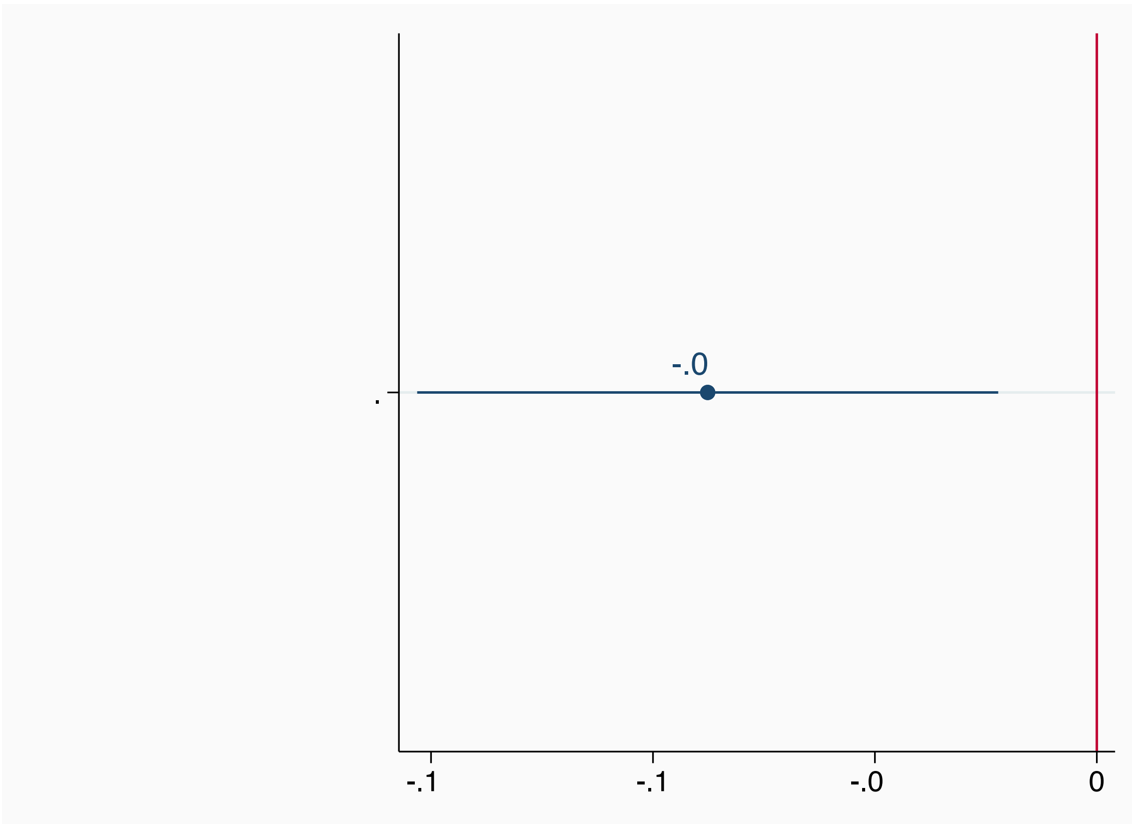
Figure 2: Percentage of SAPEC Inputs/tools Received by Treatment Status

4 Impacts of smallholder input subsidies

In order to estimate the impact of the intervention on income and agriculture production of the input recipient is ${}_1 + {}_2$.

All eight questions in the survey are dichotomous (1/0, for a rmed/denied) and the FIES scale is a summation of all eight questions. Answering a rmatively on 1-3 questions indicates mild food security. A rmative answers for 4-6 are considered moderate food insecurity and 7-8 a rmative responses places a household in the severe category of food insecurity.

Figure 3: Food Security Scale: Severe Households Only - ANCOVA: Average Treatment E ect

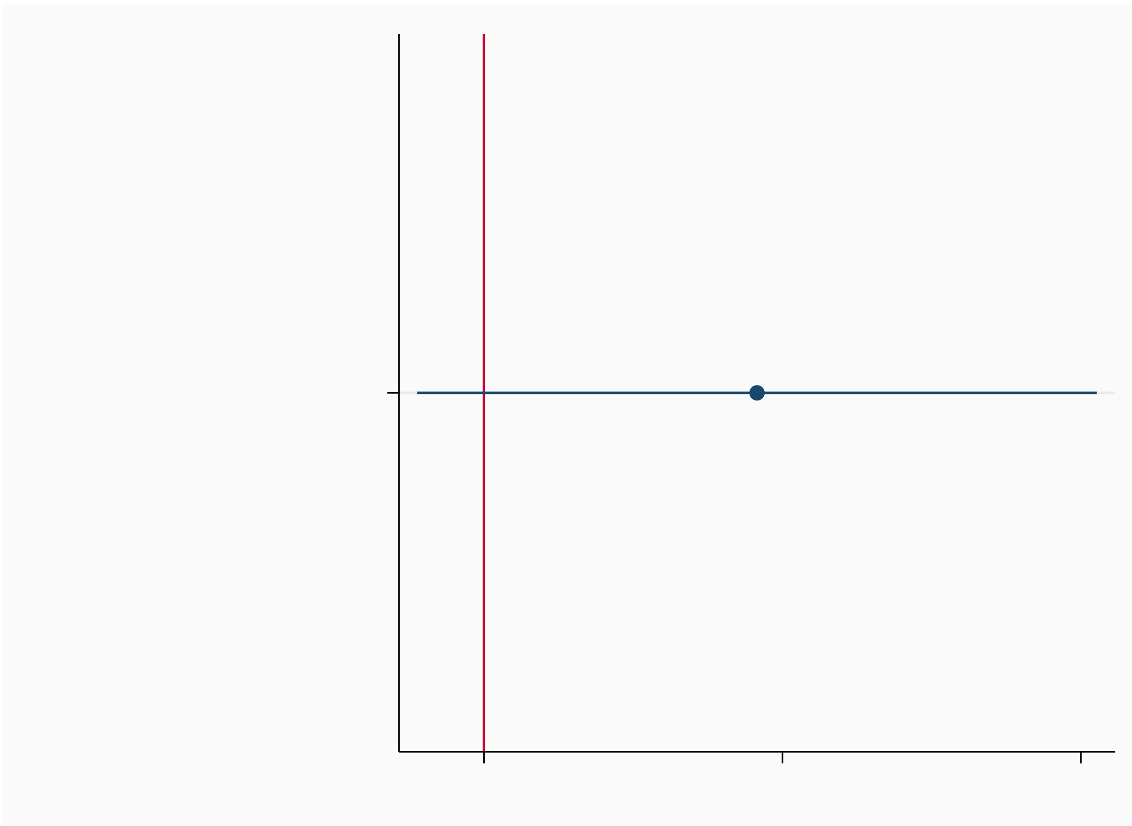


Notes: Covariates included: None, district FE = YES, SE Clustered = community. n

Figure 3 shows the e ect of being in a input distribution community the likelihood that a household is categorized as severely food insecure. This e ect is estimated through equation 1, where the outcome y is an indicator variable which equals 1 if FIES score>6. We can therefore interpret the estimate of $_1$ as approximately the change in proportion of households who are categorized as food insecurity caused by the support to smallholders through the input distribution activities. The intervention led to a 8% percent reduction in households experiencing severe levels of hunger

a community that receives inputs. This intriguing result may suggest that among the registered farmers share, give, or sell inputs to other registered farmers, so that the gains from the program are not limited to only the farmers who receive the inputs.

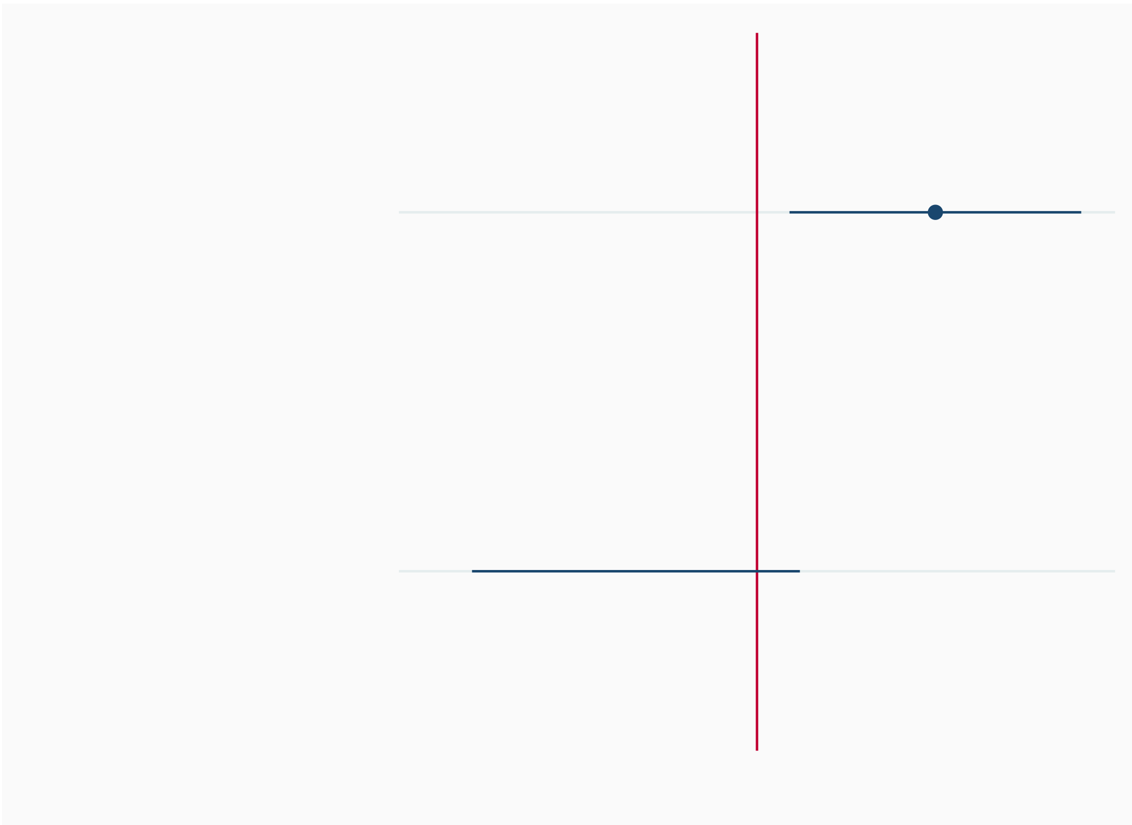
Figure 5: Food Security Scale: Moderate Households Only - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

Figure 5, repeats the impact estimate, this time using moderate insecurity as the outcome of interest. The result shows shows that there was a small *increase* in households living with moderate levels of hunger in the input distribution communities in endline. However, we can not reject that this e ect is zero. Recall from above that the input distributions are associated with declines in the proportion of households who are severely food insecure. Since most households who are no longer severely insecure will still be moderately food insecure, this increase should be interpreted as positive progress on food insecurity by moving people severe to moderate insecurity.

Figure 6: Food Security Scale: Moderate Households Only - ANCOVA: Individual & Community Treatment Effect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

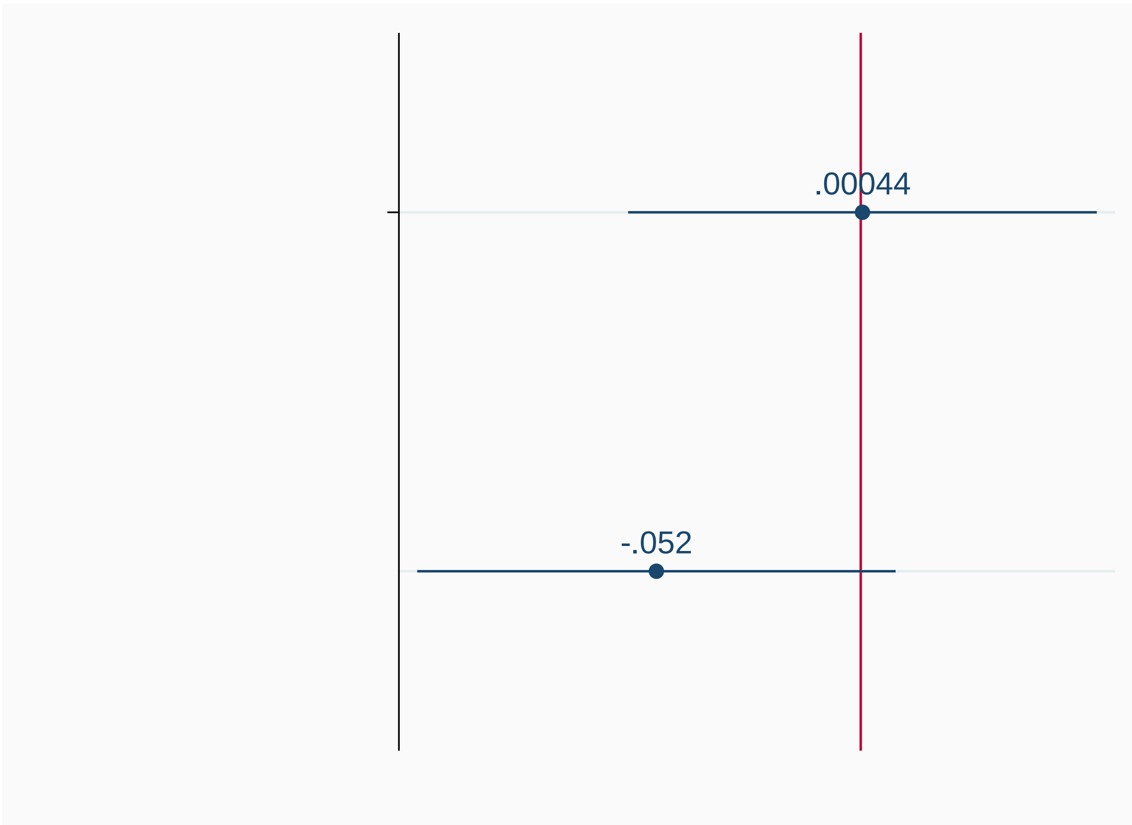
Figure 6 separates the impact on moderate food security between non-recipients in distribution communities (top bar) from the additional effect of being a direct input recipient. This disaggregation reveals that most of the increase in moderate food insecurity was concentrated among those who did not directly receive inputs, since the change in moderate food insecurity was 7.1% smaller among direct recipients than those in the same communities who did not directly receive subsidies. However, although the difference between direct and indirect recipients on this measure is meaningful, we can not reject at standard levels of significance the hypothesis that the increase was no smaller among direct recipients.

Figure 7: Food Security Scale: Moderate or Severe Households Only - ANCOVA: Average Treatment E ect

Notes: Covariates included: None, district FE = YES, SE Clustered = community.

The results above indicate that the distribution of farm tools and inputs was associated with declines in severe insecurity with smaller declines in moderate food insecurity that were o set somewhat by some people moving some households ending up moderately food insecure who had previously been severely food insecure, to test whether the input distribution led to overall declines in both categories, Figure 7 estimates the impact using a dummy which equals one when the FIES score is moderate *or* severe (FIES>3). There was a 5% percentage point reduction in the number of households who lived in input distribution communities experiencing either moderate or severe levels of hunger during endline.

Figure 8: Food Security Scale: Moderate or Severe Households Only - ANCOVA: Individual & Community Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

Figure 8 reports the same measure using equation 2, so that we can again separate the impacts for direct recipients from other members of the community. Again, the impacts are concentrated among non-recipients, but the di erence is not statistically signi cant.

The above analysis uses standard FAO categories to sort the impacts into moderate and severe food insecurity. To further show the full data on where these changes appear, Figure 9 depicts the proportion of households from baseline to endline as the FIES score decreases by treatment status. The proportion of households who report the maximum level of food insecurity by this scale was very high, with both treated and control communities having well over 60% of households answering a rmatively to all 8 questions before the input distribution round covered by this IE started. These high rates may be attributable to the di cult conditions following the ebola crisis which preceded the baseline survey. The proportion of households scoring the maximum 8 on the FIES scale declined in both treatment and control communities, but the decline was larger in treated communities, which accounts for much of the decline in severe food insecurity in treated communities. Most of the households who were reporting a score of 8 in the endline report scores of 4-7 in the endline, which is why the impact is concentrated in the severe category rather than moderate category.

Figure 9: Food Security Scale: Proportion by Treatment Status

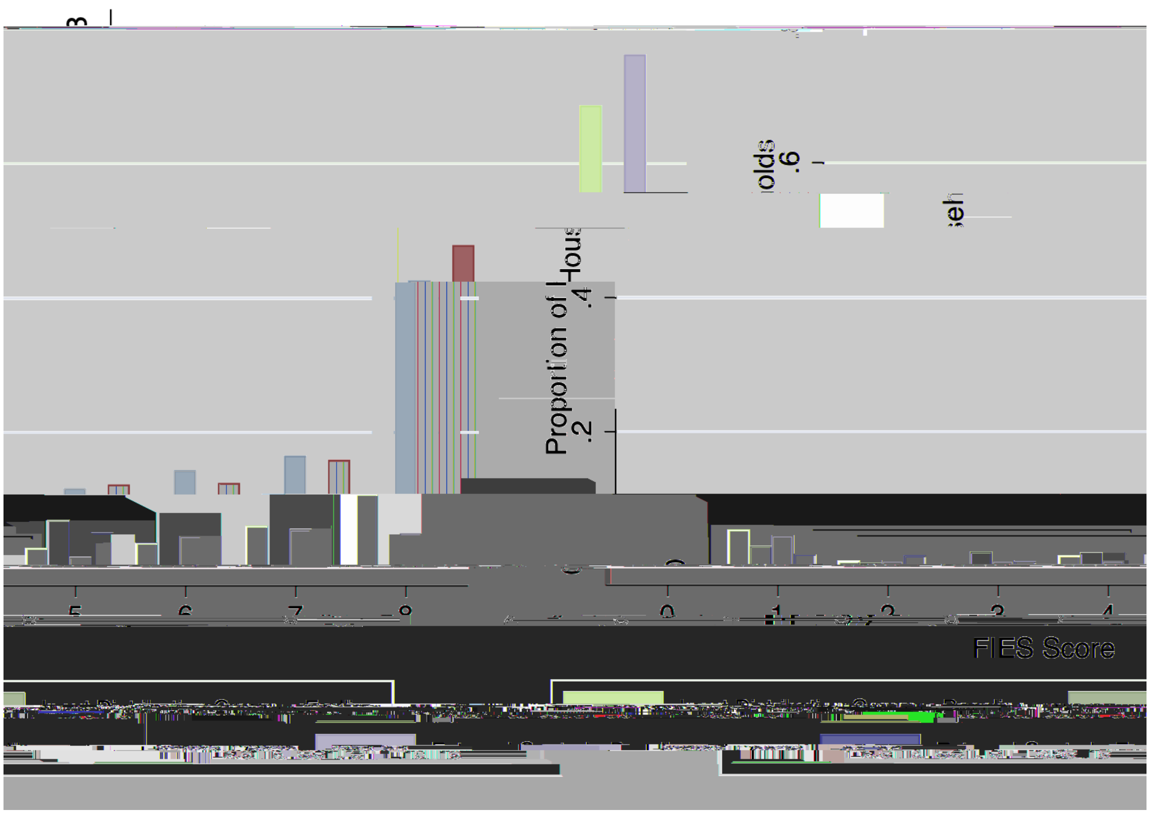
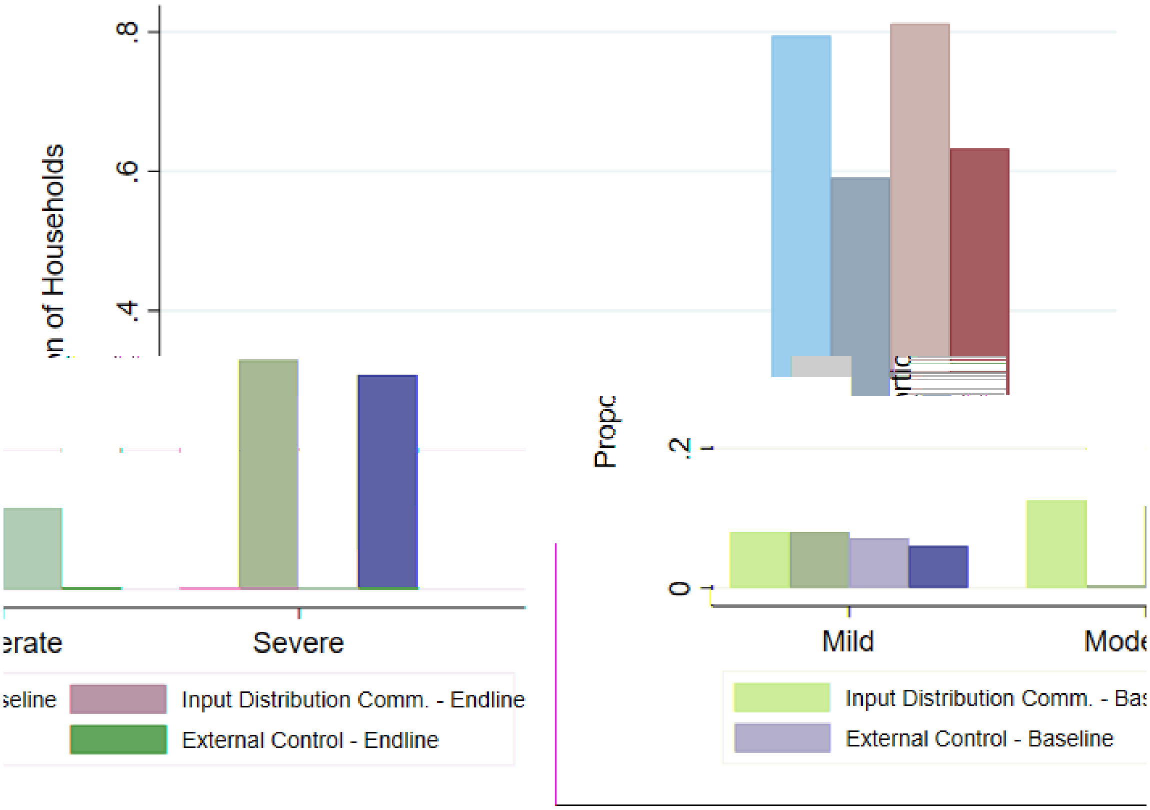


Figure 10 depicts the same results as above but by FIES status and treatment status of the household. As one can see there a dramatic drop in households that experience severe hunger from baseline to endline. Athough the decrease is experienced by both the input distribution commudecrease in hunger severity.

Figure 10: Food Security Scale: Proportion by Treatment Status and FIES Status



The results in this section report results using simple categories of food insecurity with changes reported as percentages, which is the easiest way to interpret changes in FIES status. Technically, FIES scores are an example of item response variables which should be handled by a Rasch model. In appendix B, we report the prevalence rates using this approach. Since the impact estimates are similar, we leave these results in an appendix in favor of the more straightforward \naive" estimates shown above.

4.2 Household Income and Assets

In addition to food insecurity from FIES, the other primary indicator for GAFSP nanced projects is household income. Total farm income in this evaluation is measured through income from crops, livestock, and other agricultural and livestock income. Total non-farm income includes income from non-agricultural personal business, renting land, sale of land, remittances, interests and dividends, pension, allowances, earning from labors, and other sources.

This section reports results of the input distribution intervention on household income.

The simplest way to report the impact of the input distribution on household income is to compare average income from the sources covered in the survey of households living in communities where eld teams delivered inputs with communities where inputs were not delivered during the IE before and after the input deliveries. Figure 11 reports these average. Household income in control communities declined slightly in non-input distribution communities, but increased slightly in input distribution communities, an encouraging sign that the inputs led to increases in household income.

Figure 12: Average Annual Household Income by Treatment Status: Panel Households

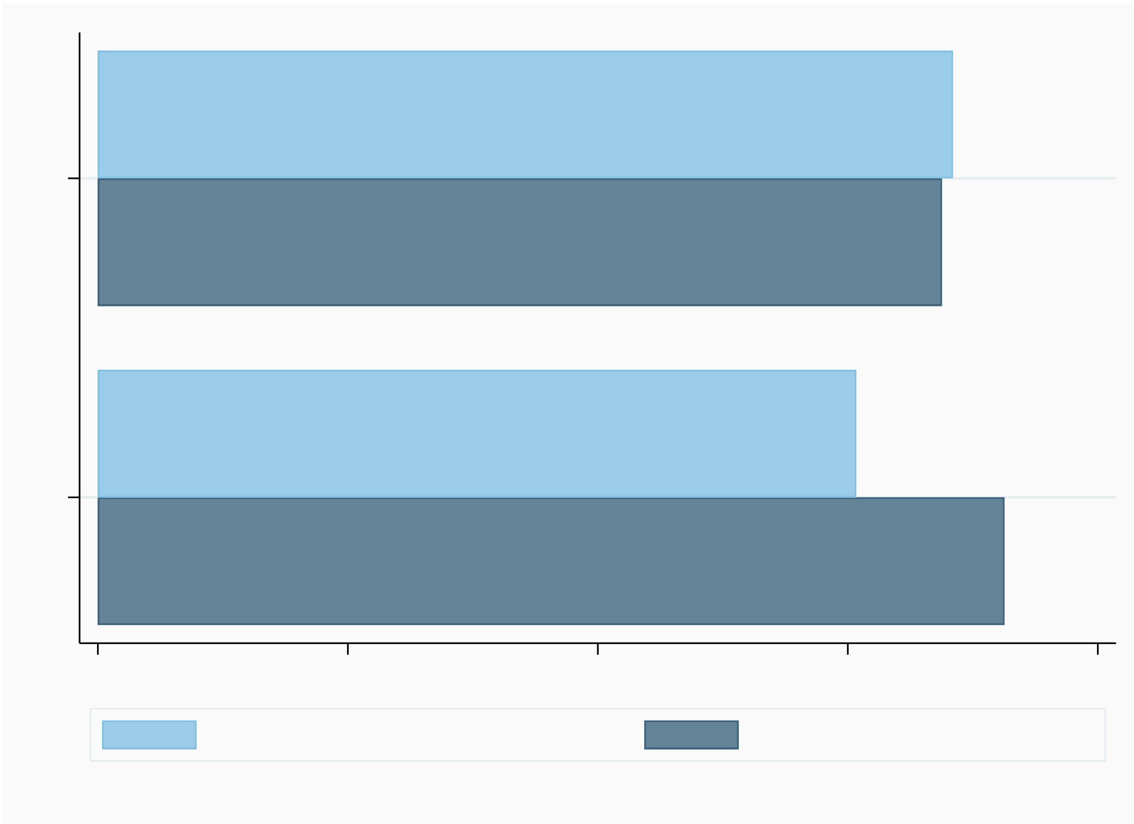
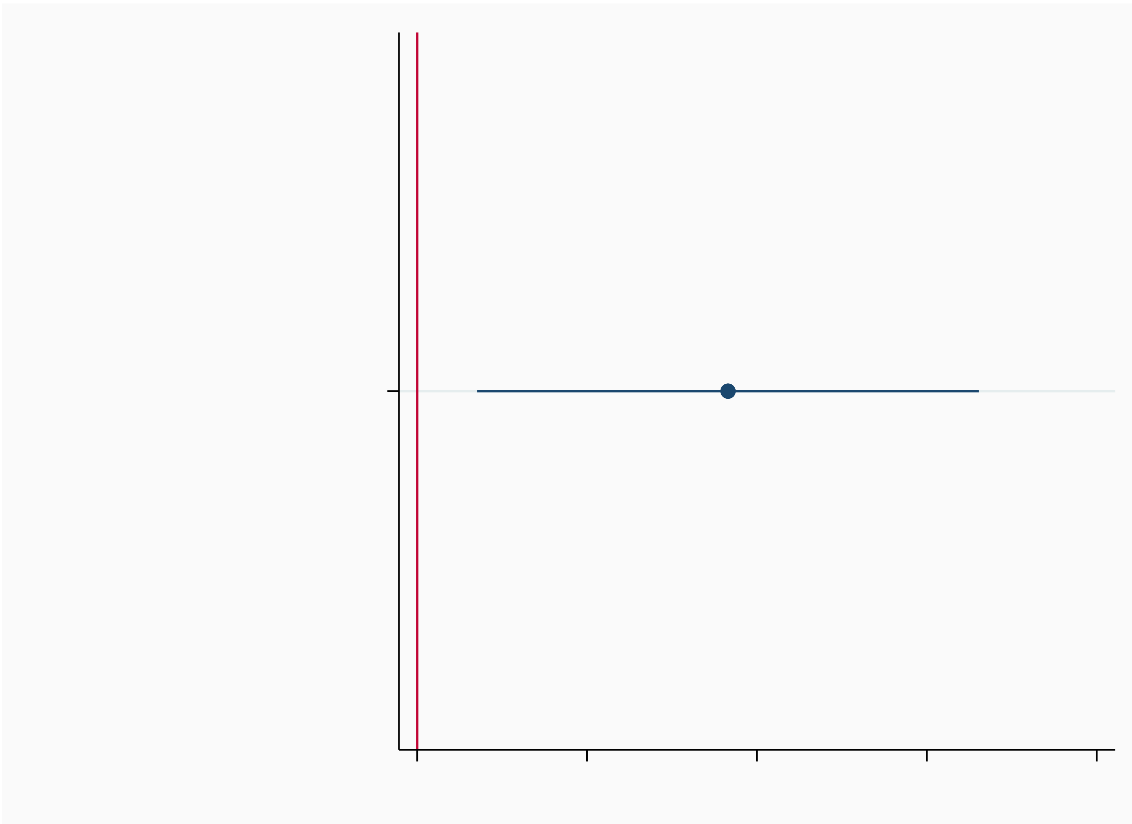


Figure 13: Annual Household Income Total (USD) - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community. Household income is winsorized at the 99% level.

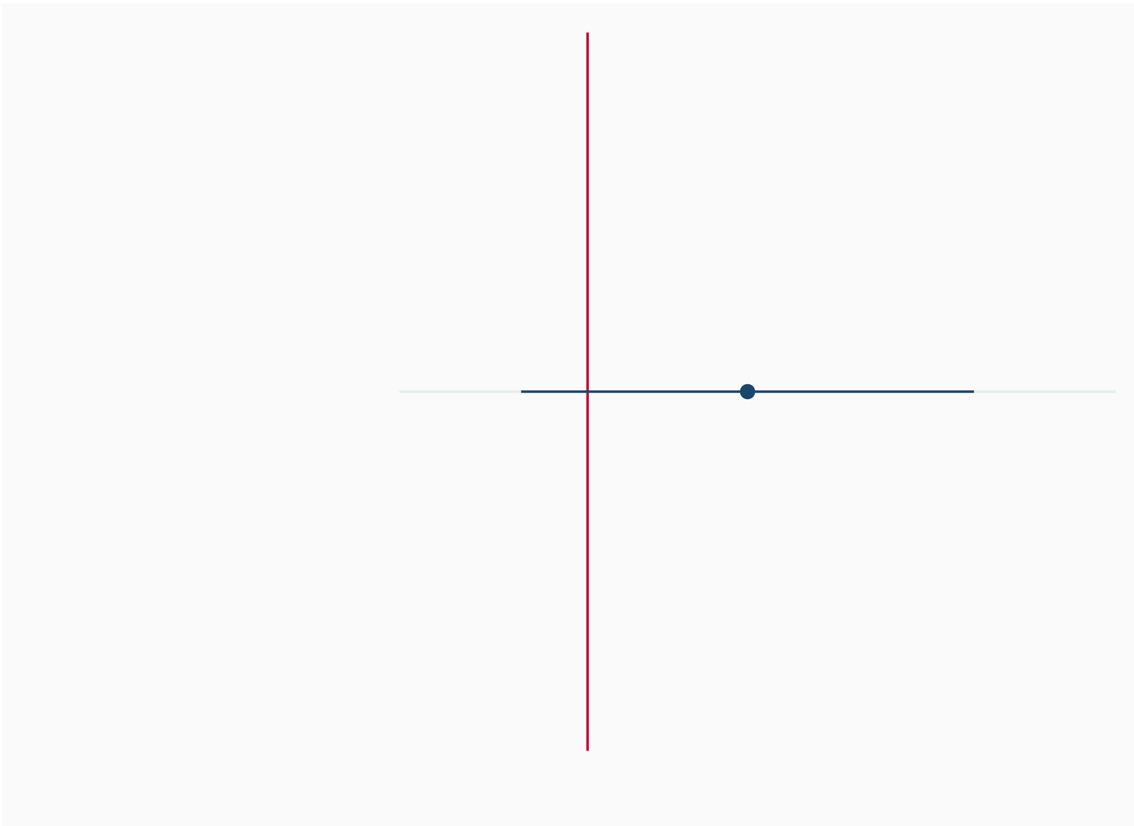
To estimate the impact of the program in the same manner as food insecurity, Figure 13 estimates

Figure 14: Annual Household Income Total (USD) - ANCOVA: Individual & Community Treatment E ect

Notes: Covariates included: None, district FE = YES, SE Clustered = community. Household income is winsorized at the 99% level.

Figure 14 disagreggates the e ect of the input distribution on direct recipients (top bar) from the additional e ect on direct recipients (bottom bar). The e ect on direct recipients is larger, as expected, but we can not statistically reject that the impacts are the same.

Figure 15: Household Farm Income (USD) - ANCOVA: Average Treatment Effect



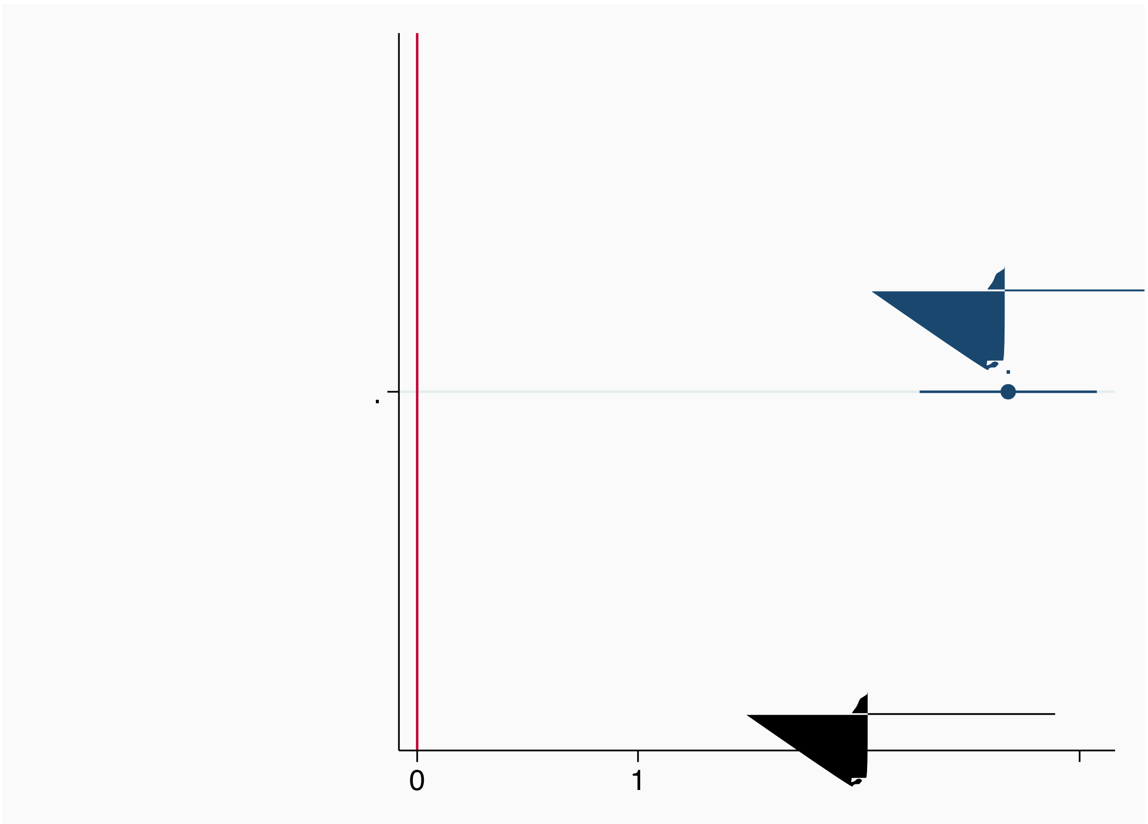
Notes: Covariates included: None, district FE = YES, SE Clustered = community. Household farm income is winsorized at the 99% level.

Because the inputs provided by the field teams were intended for agricultural use, the expectation was that the increase in income would arise specifically from increases in income earned from agricultural activities, such as sales of cultivated crops. Figure 15 re-estimates the income effect, but replacing the outcome variable with income earned from specifically agricultural sources. We find that the estimate increase in household farm income is 47 USD compared to households in non-input distribution communities. Although this effect is not statistically significant, it is nearly as large as the estimated income effect, confirming the expectation that agricultural income sources are primarily responsible for the increase in household income. The remainder of the increase may arise from households being able to slightly diversify their income sources as well.

Figure 16 below separates the farm income effect on non-direct recipients in input distribution

communities.

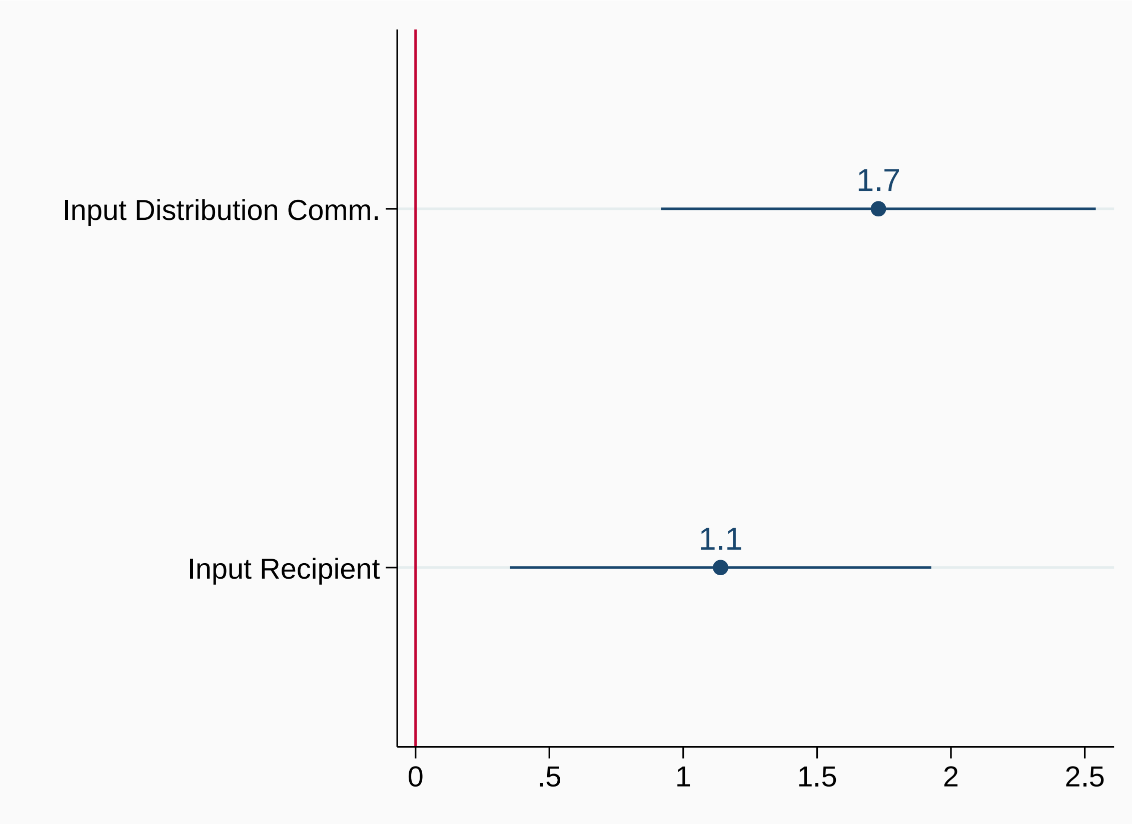
Figure 17: Farm Assets Owned Index - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

Figure 18 reveals that households that directly received the inputs provided by the extension workers received on average a little more than 1 agricultural tool compared to households that did not receive the tools. Interestingly, the households not directly treated increase their ownership of farm assets by 1.7 more assets than households in non-input distribution communities, which could indicate that input recipients sell or share their assets with other farmers who are also registered in the input distribution communities, or that there is a learning e ect about the value of owning farm tools. This result is consistent with the idea that the input distribution bene ts both direct recipients and others in their communities, but that the bene ts are concentrated most among the direct recipients.

Figure 18: Farm Assets Owned Index - ANCOVA: Individual & Community Treatment E ect



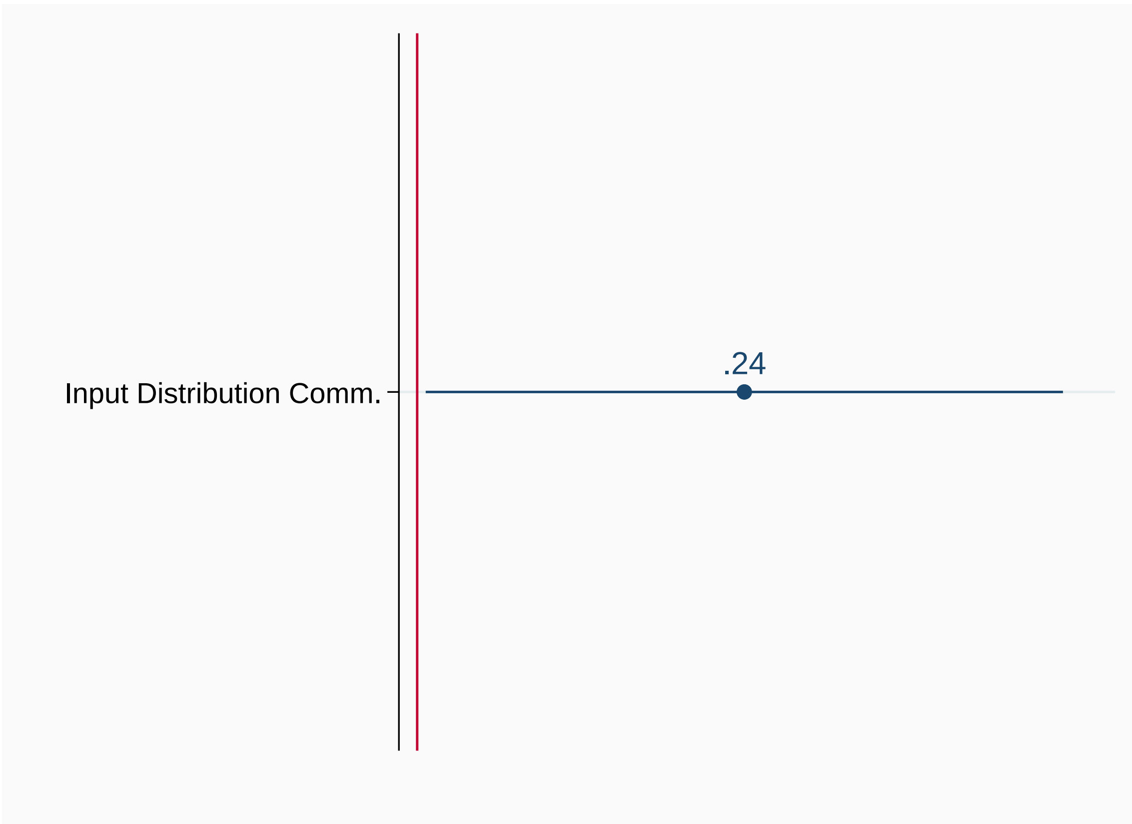
Notes: Covariates included: None, district FE = YES, SE Clustered = community.

As an additional way to measure whether the input distribution increased the welfare of farm households, created an index of assets not directly distributed by extension workers. The set of household assets owned include radio, tv set, mobile phone, electric fan, sewing machnine, bed, cupboard, table, chair, motorcycle, bicycle, wheel barrow, and peeling machine. If the input distribution improves household productivity and income, we would expect to see an increase in these assets as well.

The results below indicate there was an increase in household assets of households living in input distribution communities and input recipients.

When examining the e ect of the intervention coupled with households that received the inputs provided by extension workers the e ect increases for households that are living in input distribution communities. Figure 19 shows that households living input distribution communities increase the number of assets they owned by .25 assets. However, the result is not quite signi cantly di erent from zero.

Figure 19: Household Assets Owned Index - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

5 Changes in Agricultural Practices Associated with Input Distribution

The sections above report the impacts on the most important high level outcomes (food security, income, assets owned) associated with being a registered farmer in a input distribution community.

This section reports on changes in household agricultural activities to try to understand the mechanisms through which distribution of highly subsidized tools and seeds increases farm income and food security.

5.1 Agriculture production

Most agricultural production is for home consumption and the majority of farmers grow upland rice, lowland rice, and cassava. These three crops were the focus of the input distribution program to improve the varieties used by farmers in project areas. To investigate whether tools were used to increase production of these major crops, Figure 24 shows the increase in KG/household produced of these major crops.

Since the input distribution included vegetable seeds, some farmers received vegetable seeds as part of their input package. Consequently, the income e ect could arise from households cultivating more vegetables rather than increasing their production or productivity of staple crops. Figure 25 below shows that households in input distribution areas increased their production of vegetables by 58 kg per households compared to non-input distribution communities.

Each of the results on staple crop cultivation and input distribution communities is not individually statistically signi cant. This is because although nearly every household cultivates one of these crops (upland rice, lowland rice, cassava, or vegetables), most households do not cultivate any given one, so for most households, the value of production is zero kg. However, the combination of these results suggests that the income and food security results arise from a combination of both increased production of cassava and lowland rice and from a relative shift toward increasing vegetables. The combination of more cassava for some houseohlds and more high price vegetables for a potentially di erent subset of farmers together leads to higher incomes on average.

Figure 20: Top 10 Most Harvested crops (kg/household): All households

Figure 22: Top 10 Most Harvested Crops by Percent: All households

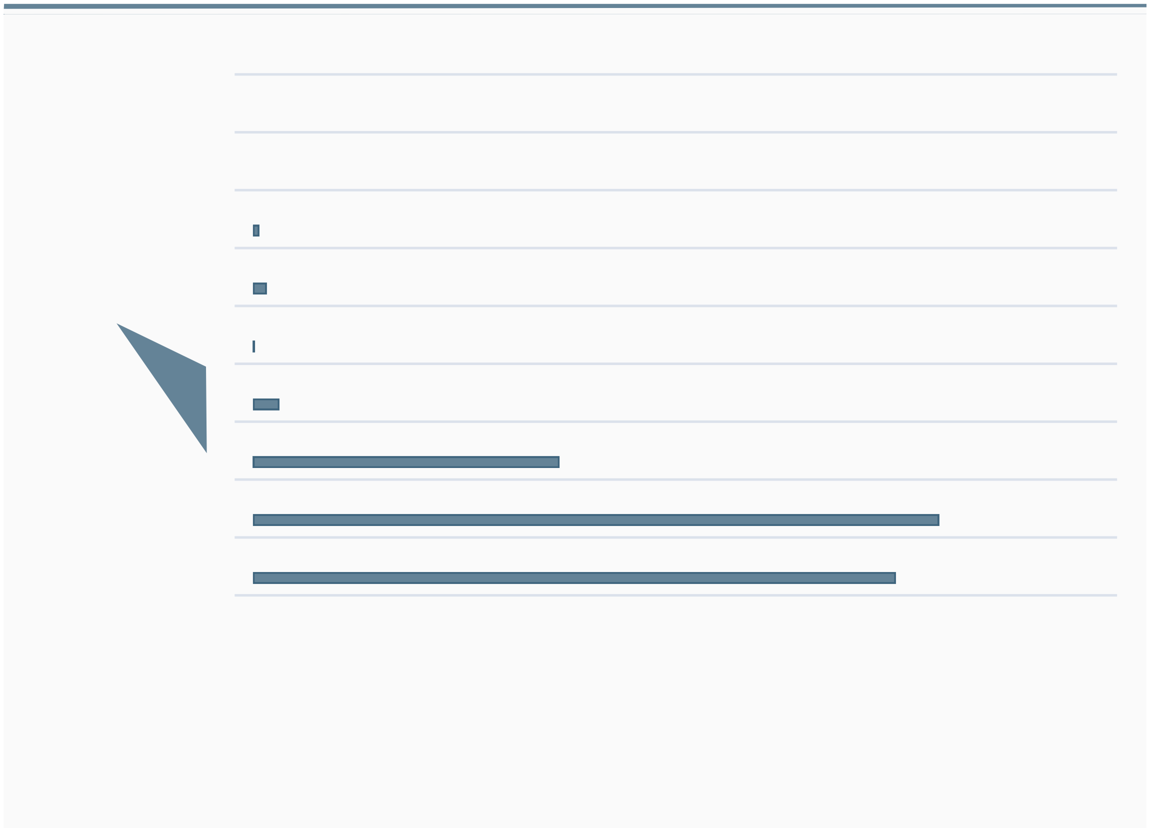
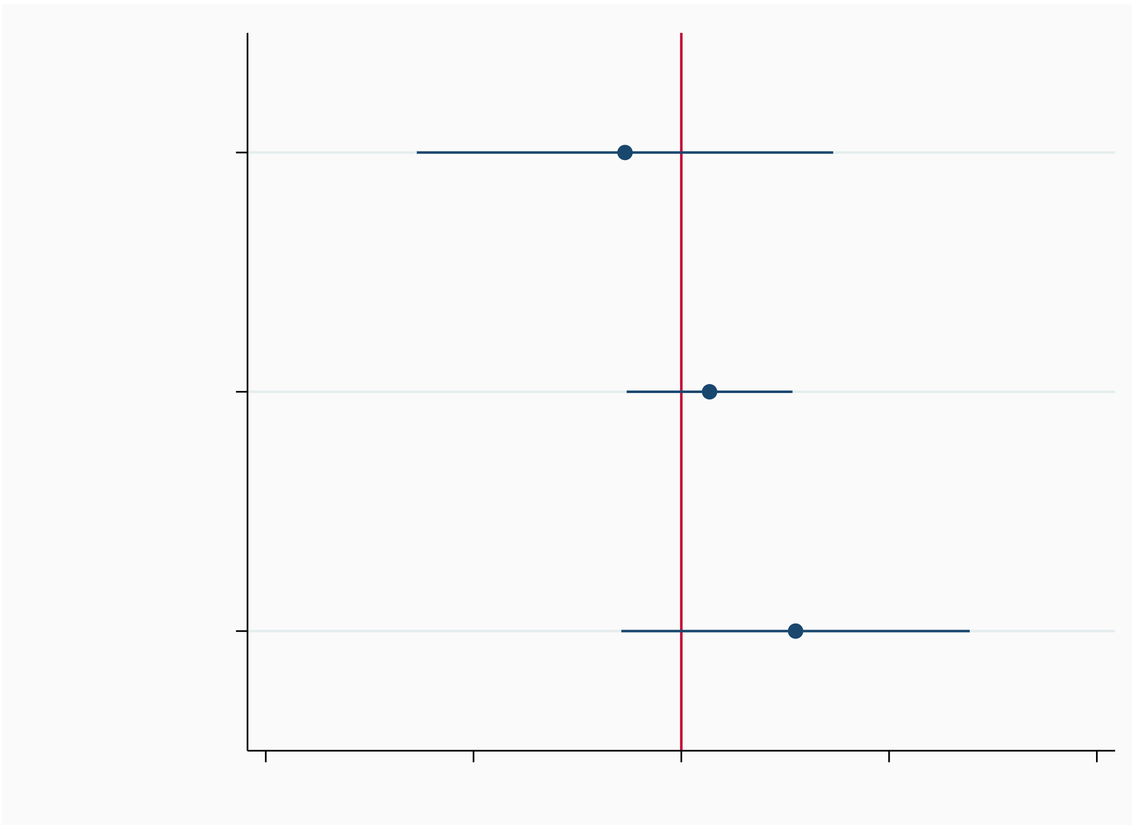


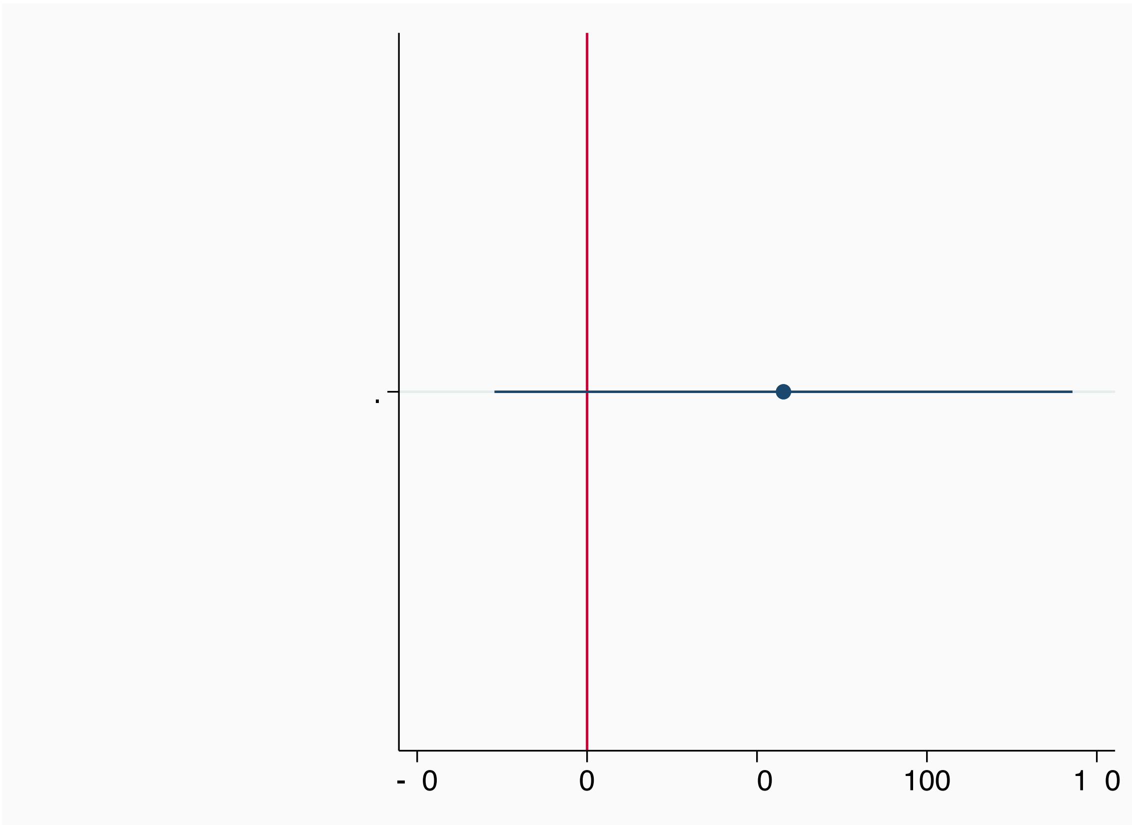
Figure 23: Top 10 Most Harvested Crops by Percent: Panel households

Figure 24: Increase in Annual Production of Primary Crops (kg/household) - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community. Upland rice, lowland rice, and cassava harvest production are winsorized at the 99% level.

Figure 25: Increase in Annual Production of Vegetables (kg/household) - ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community. Production of Vegetables is winsorized at the 99% level.

5.2 Use of Agricultural Technology

Another channel through which having access to more farm tools may have increased farmers income and food security is if these tools helped them more easily adopt improved agricultural practices. Extension activities were happening in both input distribution communities and communities not doing input distribution, so a fairly to nd changes in adoption of these technologies does not mean that the extension was not e ective, only that the inputs distributed by the project do not make farmers more likely to adopt these practices. On the other hand, if we nd that practices are more likely to be adopted in input-distribution areas, it's a signal that access to basic farm tools is a constraint to adoption of these technologies.

The survey asked households whether they adopt any of the following practices: manure, mulching, compost, soil mounds, plant nursery, IPM, and inter-cropping. These practices are the ones promoted by the eld teams through their extension activities.

Figure 26 shows that farmers in the input distribution community experience a 5 percentage point increase in the use of inter-cropping compared to farmers in non-input distribution communities, suggesting that this is the practice most constrained by access to inputs.

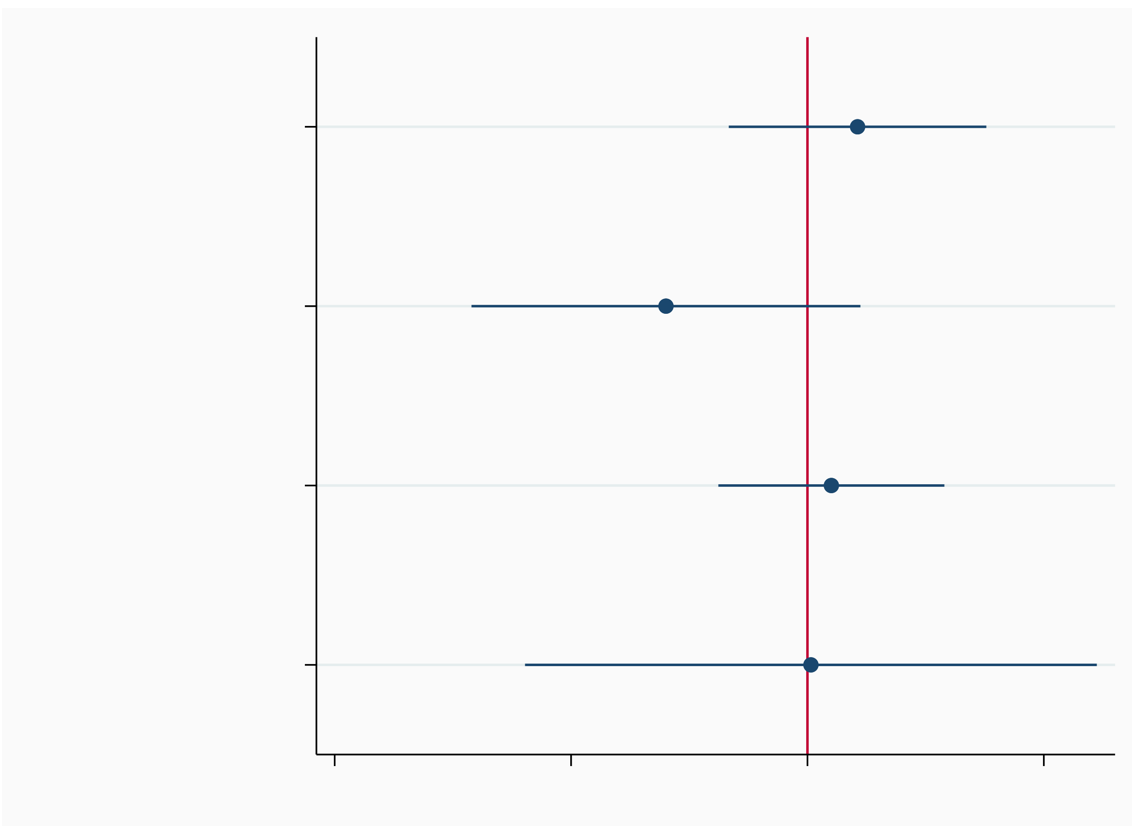
Figure 26: Use Agricultural Technology: ANCOVA: Average Treatment E ect

Notes: Covariates included: None, district FE = YES, SE Clustered = community.

5.3 Use of Agricultural Inputs

Like improved practices, adoption of other modern inputs not provided by the input distribution program may be increased when farmers have access to the tools that were provided by the extension workers does provide. Examples of such inputs that may be important for agricultural practices, but not directly provided as part of the input distribution include organic fertilizer, chemical fertilizer, pesticides, and improved seeds. There are no signi cant increases in the use of agricultural inputs from baseline to endline that is observed in the data even though more farmers did use more inputs during endline than during baseline. This suggests that access to basic tools does not lead farmers to adopt these other complementary inputs, and these inputs are not likely a channel through which income increases when tools and vegetables seeds are distributed.

Figure 27: Use Agricultural Inputs: ANCOVA: Average Treatment E ect



Notes: Covariates included: None, district FE = YES, SE Clustered = community.

6 Distribution of Inputs Through Agro-Dealers

During the course of the impact evaluation, inputs were also distributed by private agro-dealers. The dealers distributed subsidized fertilizer and improved varieties in some communities. The improved varieties distributed through the private agro-dealers were developed through partnerships supported by SAPEC. Originally, these improved seeds and seedlings were intended for distribution by SAPEC, and would have been included in the impact evaluation. However, when distribution shifted to private agro-dealers through LATA rather than SAPEC, the consequence was that improved varieties were distributed in both input distribution treatment and non-input distribution control communities. However, since SAPEC supported the development of both the improved varieties and the e-registration system through which vouchers for LATA inputs are delivered and redeemed, we include here descriptive results on the delivery, take-up and use of these inputs.

The private agro-dealers' system operated by distributing vouchers for fertilizer and seeds. Text messages were sent to farmers who enrolled in the national e-registration platform with a voucher. Farmers who received the messages were able to purchase the inputs from the agro-dealers at a subsidized price.

Table 5 depicts the number and percentage of farmers from baseline to endline who received the text messages and also were able to purchase the inputs at a subsidized price. The program was e ective in sending out text messages during baseline as a majority of households across all treatment arms reported receiving the text messages. Unfortunately, the percentage of households who redeemed the inputs at the subsidized price is lower. These low redemption rates could be caused by di culty in accessing the inputs through private shops or di culty meeting the subsidy match.

Table 5: LATA Redemption: Distribution list

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
	(%)	(%)	(%)
LATA text message received	340	250	204
	(83.74)	(75.53)	(83.95)
LATA input redeemed	84	50	34
	(20.69)	(15.11)	(13.99)
N	406	331	243

Numbers in parenthesis are column percentages

The gures displayed are obtained from the LATA distribution list

Table 6 the number of farmers that redeemed the inputs from baseline to endline by age. The gures compares farmers aged 35 or younger to farmers 36 or older.

Table 6: LATA Redemption by Age: Distribution list

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
LATA text message received - Age 17-35	87	65	43
	(82.86)	(84.42)	(78.18)
LATA input redeemed - Age 17-35	20	12	9
	(19.05)	(15.58)	(16.36)
LATA text message received - Age 36-90	253	185	161
	(84.05)	(72.83)	(85.64)
LATA input redeemed - Age 36-90	64	38	25
	(21.26)	(14.96)	(13.30)
N	406	331	243

The gures displayed are obtained from the LATA distribution list

Table 7 and Table 8 re ect that regardless of gender both female and male headed households aged 36-50 received the text messages and redeemed the inputs that were subsidized by the private agro-dealers compared to their younger counterparts aged 17-35.

Table 7: LATA Redemption by Age: Distribution list - Male Household Heads

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
LATA text message received - Age 17-35	66	42	27
	(86.84)	(84.00)	(77.14)
LATA input redeemed - Age 17-35	14	7	6
	(18.42)	(14.00)	(17.14)
LATA text message received - Age 36-90	171	126	109
	(86.80)	(76.83)	(81.95)
LATA input redeemed - Age 36-90	47	23	14
	(23.86)	(14.02)	(10.53)
N	273	214	168

The gures displayed are obtained from the LATA distribution list

Table 8: LATA Redemption by Age: Distribution list - Female Household Heads

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
LATA text message received - Age 17-35	21	23	16
	(72.41)	(85.19)	(80.00)
LATA input redeemed - Age 17-35	6	5	3
	(20.69)	(18.52)	(15.00)
LATA text message received - Age 36-90	82	59	52
	(78.85)	(65.56)	(94.55)
LATA input redeemed - Age 36-90	17	15	11
	(16.35)	(16.67)	(20.00)
N	133	117	75

The gures displayed are obtained from the LATA distribution list

The results in table 9 indicates that based on the endline surveys most did not report purchasing the subsidized inputs and when farmers did purchase them, they mostly bought fertilizer. The results could suggest that even at the subsidized price, most farmers found it di cult to access the inputs that were available.

Table 9: LATA Inputs Purchased: Endline Survey Response

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
Rice Seed	11	9	2
Cassava Cuttings	6	3	0
Vegetable Seeds	1	1	1
Fertilizer	16	17	4
N	406	331	243

The gures displayed are obtained from the Endline survey response

Tables 10 and 11 show that the low take-up rates were similar across female and male headed households.

Table 10: LATA Inputs Purchased: Endline Survey Response - Male Household Heads

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
Rice Seed	9	6	1
Cassava Cuttings	5	1	0
Vegetable Seeds	1	1	0
Fertilizer	11	10	3
N	273	214	168

The gures displayed are obtained from the Endline survey response

Table 13: LATA Inputs Purchased: Endline Survey Response - Farmers 36 or Older

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
	N	N	N
Rice Seed	8	8	1
Cassava Cuttings	5	2	0
Vegetable Seeds	1	1	0
Fertilizer	13	13	3
N	301	254	188

The gures displayed are obtained from the Endline survey response

One of the leading reasons why the inputs intake is so low is because a substantial amount of farmers reported not being able to avoid the inputs at the subsidized price. Several farmers reported receiving the text messages that was sent out but were unable to purchase the inputs at the time as results of not having any money or having less than the subsidized price of the input.

7 Cassava Processors

The other major activity sponsored by SAPEC in addition to the input distribution program was the establishment of cassava processing centers because the number of these facilities was very small and their location was necessarily xed, it was not possible to create a su ciently large comparison group of identical farmers exposed and not exposed to these centers. However, in order to describe to the extent possible the in uence of these centers on farmers activity, we include here a descriptive comparison of farmers who sell cassava to the centers with the rest of the farmers in our sample who do not sell to these centers. It must be noted that the descriptive statistics below only focuses on farmers exposed to the cassava processing center in Montserrado county, speci cally in the capital city of Monrovia.

These farmers slightly di er from the farmers in the rest of the sample as they predominantly only

as the primary mode of transportation to the storage unit compared to cassava processors.

Table 17: How Many Times Were Crops Sold - Cassava & Non-Cassava Processors

	Non-Cassava Processors	Cassava Processors
	Proportion	Proportion
1 time	0.07	0.06
2 times	0.03	0.01
3 times	0.03	0.02
4 times	0.01	0.01
5 time	0.02	0.00
6 times	0.00	0.00
7 times	0.00	0.00
8 times	0.00	0.01
9 time	0.00	0.00
10 times	0.00	0.00
N	1072	89

Table 18: Who Decides What to Do With Household Earnings - Cassava & Non-Cassava Processors

	Non-Cassava Processors	Cassava Processors
	Proportion	Proportion
Male household member decides	0.24	0.19
Female household member decides	0.15	0.13
N	1072	89

Table 18 depicts which gender of the household head makes the decision of what to do with the household earnings. In both non-cassava and cassava processor households, majority of the time the male head of the household decides what to do with the household earnings.

Cassava processor farmers do di er from farmers in the rest of the sample with regards to upland rice, lowland rice, age of household head, and household size. Table **??** in the appendix depicts a balance table of household characteristics comparing non-cassava processors to cassava processors.

7.1 Food Security & Household Income Measures

SAPEC constructed Cassava processing centers in these ve districts; District 3, Juarzon, Greater Monrovia, Suakoko, and Careysburg. Because the input distribution impact evaluation was planned before the Cassava processing centers were planned. Only three cassava processing districts overlap with the input distribution impact evaluation. The three districts are Careysburg, District 3, and Juarzon.

Below are the food security and household income impacts of providing the farm tools and inputs to the farmers that live in these three districts.

Table 19: FIES Severe - Cassava Processors Districts

	(1) Baseline - Endline
Input Distribution Comm.	-0.211
	(0.130)
Lagged of es severe at Baseline	0.103
	(0.129)
Has District FE	YES
Observations	67
R-squared	0.05

Table 20: Household Total Income - Cassava Processors Districts

	(1) Baseline - Endline
Input Distribution Comm.	-197.841
	(155.141)
Lagged of (w)tot hh income at Baseline	1.158**
	(0.461)
Has District FE	YES
Observations	67
R-squared	0.23

8 Southeast Districts: Food Security & Household Income Measures

The gures below indicate the impact of living in a southeast district on household total income and household food security. The results are shown to compared whether households living in Southeast districts experience a greater impact of the intervention than household living in Northwest districts of the country.

The food security and household income impacts of providing the farm tools and inputs to the farmers that lived in input distribution communities in the southeast districts are below.

Figure 28: FIES Severe - Southeast Districts

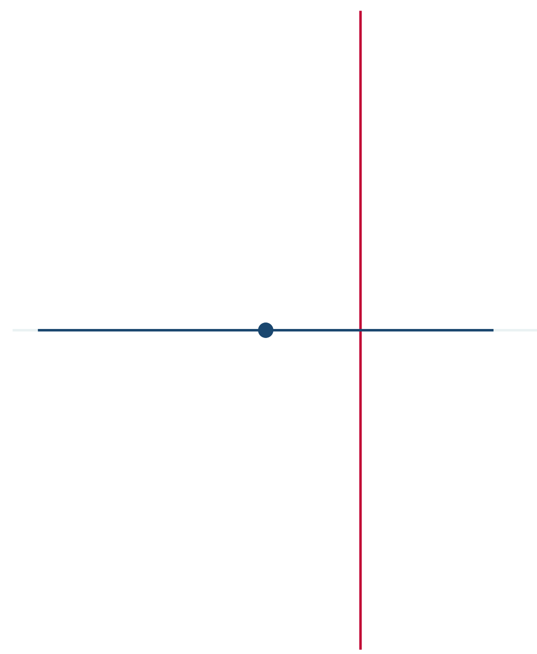
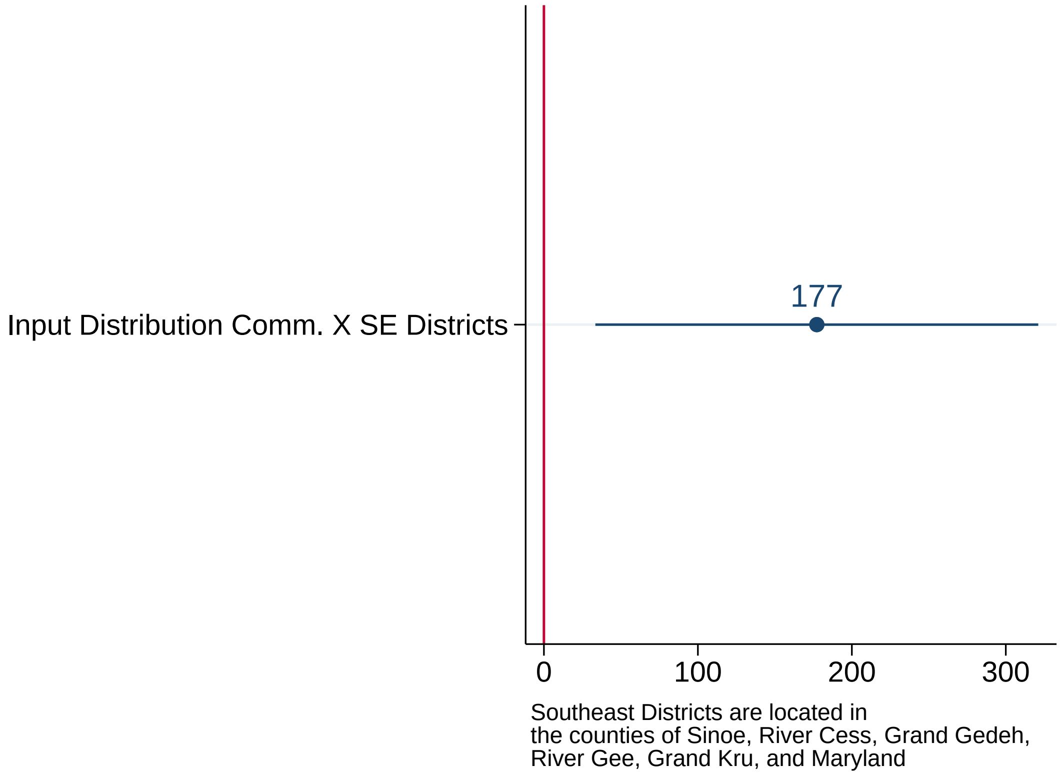


Figure 29: Household Total Income - Southeast Districts



9 Market Access

Market access for the farmers was another lens in which to examine the the impact of the intervention. As one can see it takes most farmers almost two hours by feet to get to the nearest market to sell their harvested crops and this is consistent across all three treatment arms.

Table 21: Distance to Market from Farm (Mins)

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
Distance (Walking)	108.94	112.52	113.04
N	432	343	254

When traveling from the their homes to the nearest market, the primary mode of transportation is either by car or motorbike. In transporting their primary crops to the nearest market this is where one see di erences in transportation cost between the treatment arms. Farmers in non-input recipient communities spend the most on aggregate transporting their primary crops to the nearest market compared to farmers in the external control and input recipient communities.

Table 22: Transportation Cost to Market for Primary Crops (USD)

	External Control	Input Recipient	Non-Input Recipient
	Endline	Endline	Endline
Upland Rice	11.82	10.08	8.78
Lowland Rice	14.65	10.23	27.28
Cassava	13.00	9.97	22.31
N	432	343	254

The main method of transportation to the market is either by car or motobike

10 Conclusion

The this report highlighted the main results from DIME impact evaluation of the smallholder inputs distribution program. The result nds that farm households residing in communities randomly assigned to participate in the input distribution program during the impact evaluation had greater declines in severe food insecurity and greater increases in income compared to registered farmers

11 Appendix

A Access to extension workers

This section presents further information on access to extension workers by IE treatment groups. The evaluation only assigned subsidized inputs and not extension, so both treatment and control groups could be receiving extension advice. This section shows the growth in access to extension from baseline to midlin.

In general, the farmers in endline used extension services more compared to baseline. About 27% of farmers were not visited by either a government, SAPEC eld team, or NGO extension worker in year prior to the endline survey, compared to 67% of farmers were not visited by any extension workers. The results show that the project was e ective in getting extension workers to visit households.

Table 23: Extension Worker Visited Household

	Baseline Proportion	Endline Proportion
SAPEC worker	0.22	0.63
Ministry of Agriculture worker	0.11	0.21
NGO worker	0.14	0.13
SAPEC & Ministry of Ag worker	0.07	0.16
SAPEC & NGO worker	0.07	0.08
Ministry of Ag & NGO worker	0.05	0.06
None Visited	0.67	0.28
N	1116	1237

Table 24 displays extension worker visits by treatment status. A majority of households in each treatment arm reported being visited by a SAPEC extension worker.

Table 24: Extension Worker Visited Household: Treatment Status

	External Control		Input Recipient		Non-Input Recipient	
	Baseline Proportion	Endline Proportion	Baseline Proportion	Endline Proportion	Baseline Proportion	Endline Proportion
SAPEC worker	0.20	0.52	0.25	0.83	0.16	0.59
Ministry of Agriculture worker	0.11	0.20	0.11	0.25	0.13	0.20
NGO worker	0.14	0.13	0.14	0.13	0.17	0.15
SAPEC & Ministry of Ag worker	0.08	0.12	0.06	0.22	0.05	0.14
SAPEC & NGO worker	0.06	0.07	0.07	0.10	0.06	0.09
Ministry of Ag & NGO worker	0.05	0.06	0.05	0.07	0.05	0.06
None Visited	0.69	0.36	0.65	0.13	0.69	0.31
N	479	537	525	344	112	356

B The rasch model for FIES analysis

The Rasch model provides statistical methods to estimate the severity of each item and each household to determine which response pattern in the dataset are consistent with the severity-order concept. It combines multiple dichotomous (yes/no) questions that vary as to the point on the continuum that each question uniquely re ects. The mathematics behind the model posits that the probability of a speci c household a rming a speci c question depends on the di erence between the severity-level of the household and the severity of the question.

It should be noted that a core assumption of the Rasch model is that the questions are conditionally independent. Therefore, the question responses by households with the same true level of severity of food security are uncorrelated. In order to determine the food insecurity prevalence rates using the Rasch model, an R package was developed by the Voices of the Hungry (VoH).

The results from the Rasch model will demonstrate that there was a 10% reduction in households experiencing severe levels of hunger from a baseline of 71% of households experiencing severe levels of hunger. Furthermore, the results below reinforces the regression ndings that were displayed in the previous section.

Table 26 depicts the moderate and severe prevalence rates for farmers in the endline survey. As one can see the prevalence rates drastically decreased compared to the baseline rates, which signals that households consumed more food as a result of an increase in household production.

Only 37% of households reported su ering from severe hunger from a rate of 60% at baseline and

Table 25: Sample Hunger Prevalence Rates: Baseline Households

Moderate + severe	N	Severe	N
98:736	713	60:907	713

Table 26: Sample Hunger Prevalence Rates: Endline Households

Moderate + severe	N	Severe	N
87:918	713	37:824	713

87% reported su ering from moderate or severe hunger down from a rate of 98% at baseline. Part of the aim of the project was to increase household food and nutritional intake by increasing household

Table 29: Sample Hunger Prevalence Rates: Baseline Households - Input Distribution Community

Moderate + severe	N	Severe	N
97:456	422	94:879	422

Table 30: Sample Hunger Prevalence Rates: Endline Households - Input Distribution Community

Moderate + severe	N	Severe	N
75:433	422	66:720	422

The Rasch model reinforces the results displayed in the food insecurity section that the increases in production and household income led to a decrease in food insecurity.

Table 31: Sample Hunger Prevalence Rates: Baseline Households - External Control

Moderate	N	Severe	N
97:260	317	99:236	317

Table 32: Sample Hunger Prevalence Rates: Endline Households - External Control

Moderate	N	Severe	N
78:019	317	88:743	317

Table 33: Sample Hunger Prevalence Rates: Baseline Households - Input Distribution Community

Moderate	N	Severe	N
97:456	422	99:306	422

Table 34: Sample Hunger Prevalence Rates: Endline Households - Input Distribution Community

Moderate	N	Severe	N
75:433	422	86:507	422