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One Acre Fund Program Evaluation:

Analysis and Results

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Context for engagement

The impact evaluation depicted in this document was designed and executed by One Acre Fund. IDinsight was engaged by One Acre Fund as an external impact advisor after data collection was complete. IDinsight reviewed the evaluation design and analyzed the study data. This document contains IDinsight's analysis and interpretation of findings. The perspectives in this document are IDinsight's based solely on analysis of data provided by One Acre Fund and an assessment of the technical merits of the study design.[1] A separate, accompanying document that assesses limitations of the study was also created as part of this engagement.

Overview

This document provides results from an IDinsight analysis of data from One Acre Fund's (1AF's) evaluation conducted in Busia, Kenya. One Acre Fund provides input packages on loan coupled with training to small scale farmers to improve yields. In 2014, 1AF implemented an evaluation across 6 sites in Busia (4 treatment, 2 control) with 570 farmers. Three surveys were conducted throughout the growing season with the final harvest survey collecting information on maize yields for each farmer. 1AF engaged IDinsight to analyze data from these three surveys to generate an estimate of the 1AF program's impact on maize yields.

A linear regression was used to generate an estimate for the average farm-level maize yield effect size of the 1AF program. To address a high level of attrition (28%) from the harvest survey, a bounds analysis was also conducted by estimating missing yield measures for farmers lost to follow-up. Balance checks on baseline data indicators across treatment and control groups and across famers with and without missing data were conducted using Student's t-tests and chi-squared tests. There are few systematic differences on observable characteristics at baseline for farmers in treatment and control groups, and for farmers whose yield data are present and absent in follow-up surveys.

The primary regression estimates that One Acre Fund's intervention increases farm-level maize yields by approximately 370 kg/acre (95% CI: -61.39, 798.46, p-value = 0.09). The analysis controls for relevant covariates and calculates standard errors using the wild cluster bootstrap-t procedure. The estimate represents a 32% increase in maize productivity among treatment farmers.[2]

The results should be interpreted within the context of the study limitations. The most important limitations are that the study only featured 6 randomization clusters and that outcome measurement was affected by high attrition (28%). Additionally, the program likely affects many other outcomes, but this analysis only assesses impact on maize yield. **Due to these limitations, the impact estimate is less precise than what is indicated by the primary analysis, although no clear bias is detected.** See the "One Acre Fund Program Evaluation: Assessment of Evaluation Limitations" document for a more detailed description of limitations and implications for study takeaways.

Overall, the impact estimate is sizable but is only statistically significant at the 10% level and study limitations further diminish precision. **As such, our ultimate conclusion is that this impact evaluation provides an indication that the 1AF program increased farmer maize yields, and that any increases may have been large. However, the findings are not sufficiently strong to base major program decisions solely on evidence provided by this evaluation.**

[1] See Appendix for a description of the evaluation activities completed by each organization.
[2] Data analysis was conducted on the merged and cleaned data sets that 1AF provided. A more in-depth look at the raw study data did not indicate that there were significant data quality issues with the variables used in this analysis.

Background

One Acre Fund (1AF) conducted an evaluation in Western Kenya in 2014 to examine the impact of their inputs on loan program to small scale maize farmers. Six new program sites in Busia, Kenya were randomly allocated to be treatment (n=4) or control (n=2) sites for the purposes of measuring impact. Farmers in the treatment sites received seed and fertilizer on credit in addition to training. Farmers in the control sites were provided with mobile phones, bed nets, chlorine water treatment, and health and funeral insurance for one year.

1AF conducted three surveys for this evaluation, including a baseline survey on household characteristics and 2013 crop production levels at the beginning of the season, a crop-mix survey on the planted land and inputs used for the current season after planting, and a harvest survey on the yields for study farmers at the end of the season. Yield measurements for each farmer were collected by 1AF staff members, who harvested and weighed maize from 2 randomly selected land samples[3] (each 8m x 5m) for each type of land (1AF and non-1AF). 1AF evaluation staff was responsible for verifying, compiling, and cleaning all survey data.

IDinsight was engaged by 1AF after all intervention and data collection activities were complete. The following analysis uses data provided by 1AF and focuses on estimating the average treatment effect of the 1AF intervention on farmer maize yields, the primary program outcome of interest.

Analysis

Balance checks

Balance checks indicate that treatment and control farmers were reasonably balanced on observable baseline characteristics (See Appendix Table 3). Student's t-tests were used to compare means and chi-square tests were used to compare proportions. Out of 22 baseline characteristics checked, only three (sale from non-food items in the past month (KSH), loan amount received for agriculture inputs for upcoming year (KSH), and probability of being part of a merry-go-round savings group) were found to be significantly different between the treatment and control groups. All of these were greater among control group farmers compared to treatment farmers. These differences are controlled for in the primary regression model.

Additionally, there is no indication of systematic differences between farmers included in the analysis and those lost to follow-up ("attrited") across the full sample (See Appendix Table 4). Attrition rates are also similar in magnitude between treatment (26%) and control groups (29%). Out of 22 baseline characteristics checked, only three were found to be significantly different between farmers with survey data and those lost to follow-up. Sales from food items in past month (KSH) was higher among surveyed farmers, while earnings from labor in past month (KSH) and probability of having a savings account with a bank were higher among attrited farmers.

Lastly, although data from the crop-mix survey indicated two maize yield estimates were expected for each treatment farmer who cultivated two types of land (one estimate from land with 1AF inputs and another estimate from land without 1AF inputs), yield data for only one of these land types was collected for 51 treatment farmers (12% of all surveyed farmers, 24% of surveyed treatment farmers). Among these farmers, 94% of the collected yield data was from land that received 1AF inputs. Balance checks comparing these 51 farmers ("partial yield data") to the remaining treatment farmers ("full yield data") indicated few significant differences across relevant baseline indicators (Appendix Table 5). However, since dropping these farmers from the analysis or extrapolating yields from the observed

[3] IDinsight did not assess the procedure used to randomly select the plot samples.

plot could introduce bias into estimates of the program impact, these farmers are included in the analysis with missing plot yields imputed based on treatment group yield data.

Yield effect estimate

A farm yield average for maize weighted by land type size is calculated for each farmer based on the two box plot samples collected in the harvest survey for each land type (see Appendix Equation 1 and Equation 2 for this calculation). Though some of the treatment plots did not utilize 1AF inputs, this farm average is used as the primary outcome for analysis due to potential plot selection bias. If, for example, 1AF farmers selected their best (or worst) maize plots to apply inputs to, this could create an upward (or downward) bias for yields from these plots, which would increase (or decrease) the average treatment effect. A comparison of means between 1AF plots and non-1AF plots within the treatment group indicates that the 1AF plots achieve higher yields (statistically significant at $p < .01$). Since 1AF gives an amount of loan inputs to farmers that is sometimes insufficient to cover the entire farm, this approach produces valid estimates for the farm-level effect of the 1AF program.[4]

A linear regression without covariates was used to estimate the average treatment effect on farmer maize yield outcomes with clustering at the level of randomization (location site) using the wild bootstrap-t procedure.[5] The results from this regression indicate an increase in average maize yield of 368.31 kg/acre (95% CI: -19.08, 855.69, p-value = 0.14) for treatment farmers as presented in the "without covariates" model in Table 1. The primary regression model controlling for age, household size, education, social connectivity, land size, amount earned from selling food items in the past 30 days, amount of agriculture loans received, the probability of being a member of a merry-go-round savings group, and past reported harvest amount (2013) is shown in the "with covariates" model in Table 1.[6] This model indicated an increase in the average treatment effect on maize yield of 368.54 kg/acre (95% CI: -61.39, 798.46, p-value = 0.09), which represents a 32% increase in yields by the treatment group compared to the control group.[7, 8]

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[4] For treatment farmers with incomplete yield data, the missing maize yield is imputed based on maize yields of similar land types from farmers with complete data in the treatment group. 48 treatment farmers were missing yield data for the non-1AF land, so this missing value was replaced with the treatment group average non-1AF land yield. 3 treatment farmers were missing yield data for the 1AF land, so this missing yield was replaced with the treatment group average 1AF land yield. Land size estimates from the crop-mix survey were used in the weighted maize yield average for these missing yields.

[5] *Cameron, A. Colin, Jonah B. Gelbach, & Douglas L. Miller (2008) 'Bootstrap-based improvements for inference with clustered errors.' Review of Economics and Statistics 90 (3), 414-427*

[6] Age, household size, head of household education, social connectivity, and land size were controlled for as hypothesized determinants of farm production. Amount earned from selling food items in the past 30 days, amount of agriculture loans received, the probability of being a member of a merry-go-round savings group were controlled for as differences between treatment and control groups at baseline. Past reported harvest amount was included to control for potential site-level effects due to the few units of randomization used.

[7] A secondary analysis with standard errors calculated using the clustered sandwich estimator is included in Appendix Table 6.

[8] Analysis of the average treatment effect based on land type (1AF vs. non-1AF) for farmers with only one type of land was also conducted using both standard error methods and is included in Appendix Table 7 and 8. This analysis indicates a significantly higher average treatment effect, but is limited by a much smaller sample size.

Table 1. Regression models for average treatment effect size on farmer yields (kg/acre)

	Without covariates (N=413)			*With covariates (N=413)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**368.31**	**0.14**	**[-119.08, 855.69]**	**368.54**	**0.09***	**[-61.39, 798.46]**
Age				-2.21	0.19	[-5.53, 1.11]
Household size				8.35	0.47	[-14.48, 31.17]
Education						
Did not finish primary				*Ref*		
Finished primary				-47.26	0.37	[-151.76, 57.25]
Some secondary				-30.87	0.46	[-112.27, 50.53]
Finished secondary				-110.44	0.24	[-296.37, 75.50]
Beyond secondary				-28.82	0.73	[-195.76, 138.13]
Social connections				-4.32	0.87	[-56.58, 47.93]
Planting land size (acres)				59.59	0.44	[-92.58, 211.77]
Amount earned from selling food items (KSH)				-0.02	0.17	[-0.05, 0.01]
Agriculture loan amount received (KSH)				0.00	0.54	[-0.01, 0.01]
Probability of being part of a savings group				28.54	0.63	[-88.14, 145.22]
2013 Maize production (kg)				0.09	<0.01***	[0.09, 0.09]
_cons	1164.76	0.51	[-2314.94, 4644.45]	1140.36	<0.01***	[1140.36, 1140.36]

****Statistically significant at p < .01 level*

***Statistically significant at p < .05 level*

**Statistically significant at p < .10 level*

Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

Two secondary analyses were conducted to further examine the effects of the missing yield data for treatment farmers and the implications of attrition for obtaining unbiased estimates of the average treatment effect.

First, we look at the consequences of excluding farmers with incomplete data from the analysis. When the 51 treatment farmers with incomplete data are omitted from the analysis, the average treatment effect increases to 413.99 kg/acre (95% CI: -14.42, 842.39, p-value = 0.06) (Appendix Table 9). If these 51 treatment farmers with missing maize yield data are systematically different from the rest of the treatment group farmers (as this increase in the estimated average treatment effect suggests), then they should be retained in the primary analysis. However, it is important to note that if these farmers do achieve lower yields on average compared to other treatment farmers, and the estimates for these missing yield measures based on the treatment group average yields will potentially lead to an overestimation of the average treatment effect in the primary analysis.

Second, we look at the consequences of attrition on the analysis. A bounds analysis on the main model for the full sample was conducted using the 10th and 90th percentile yield amounts to test the limits of the average effect size estimates with the inclusion of the farmers lost to follow-up. Imputing extreme yields for farmers with missing data leads to a wide range of possible average treatment effects as indicated by the span of estimates from the bounds analysis (-191.63 to 702.99 kg/acre) (Appendix Table 10). This suggests a lower precision for the estimated average treatment effect than indicated by the primary analysis. However, because attrition magnitude and observable characteristics of attrited households are similar across the treatment and control groups, we have no indication due to attrition that the primary impact estimate would be biased.

Limitations

The following chart provides an overview of study limitations which should be used to contextualize the results presented above. See the "One Acre Fund Evaluation: Assessment of Study Limitations" document for a more detailed description of limitations and implications for study takeaways.

Table 2. Summary of study limitations

Potential limitation	*Description*	*Takeaway*
1. Small number of clusters	Six clusters (4 treatment, 2 control) were included in the evaluation.	The small sample size increases the margin of error / uncertainty about the impact magnitude and presents a challenge to generalizing these results across the population of farmers.
2. High level of attrition	Maize yield data could not be collected for 28% of sampled farmers.	The magnitude of attrition and baseline characteristics of attrited households is similar across groups. Potential unknown determinants of attrition, however, present uncertainty about potential biases. We do not have any reason to believe that attrition invalidates the main takeaway of this analysis (that the impact of the 1AF program may have been positive and large), but it does increase the margin of error / uncertainty about impact magnitude.
3. Incomplete treatment yield data	For 24% of surveyed treatment farmers, maize yield data was not collected for all sampled land types.	In some cases, treatment farmers cultivated land with 1AF inputs and land without 1AF inputs, meaning two maize yields should be reported. However, only 1 maize yield was collected for 51 of these farmers. A secondary analysis omitting these farmers indicated a large increase in the average treatment effect, which suggests that these farmers likely have lower yields compared to the rest of the treatment group. Balance checks within the treatment group indicate little reason to believe there are systematic differences between these farmers and the rest of the treatment group. These farmers are included in the analysis, but represent further uncertainty about the missing yield data and attrited farmers in general.

4. Control group selection and benefits	1AF revoked treatment from the control group after fees were paid and provided significant compensation to control farmers, which may have affected control farmer yields.	Control sample selection and the compensation of control group farmers could have biased the average treatment effect in either direction. We do not think there is reason to believe that these biases impacted the estimates enough to change the direction of the impact, but this possibility cannot be definitively ruled out.
5. Limitations in the research protocol	1AF conducted this evaluation in-house with staff knowledgeable of treatment group assignment collecting data. No formal protocol or analysis plan was established prior to the study implementation.	It is possible that outcomes were influenced – intentionally or not – by 1AF staff. From conversations with 1AF staff, this does not appear to have occurred, however smaller unintentional differences in data collection or implementation at the farmer level could have affected the difference in yields.
6. Intercropping	A significantly higher percentage of control farmers (67%) practiced intercropping on their maize land compared to the control farmers (15%).	The practice of intercropping could bias maize yield estimates if this altered planted maize densities. Conversations with 1AF staff indicate that this is unlikely to be the case. Additionally, this could affect the interpretation of results if intercropping acts as a mediator for 1AF program impact or if profits are sacrificed from not intercropping. Ultimately, we do not think that intercropping has a large effect on maize yields (which is the focus of this analysis), but we recommend accounting for intercropping if 1AF seeks to estimate the effect of the program on farm-level profits.

Conclusion

A regression model controlling for relevant covariates using the wild bootstrap-t method for calculating standard errors estimated an average difference in farm-level maize yields between treatment and control groups of 368.54 kg/acre (95% CI: -61.39, 798.46, p-value = 0.09). This point estimates represents a 32% increase in yield for 1AF farmers on average compared to control farmers.

The estimate is only statistically significant at the 10% level, and precision is further reduced due to study limitations. As a result, **our ultimate conclusion is that this impact evaluation provides an indication that the 1AF program increased farmer maize yields, and that any increases may have been large. However, the findings are not sufficiently strong to base major program decisions solely on evidence provided by this evaluation.**

About IDinsight

IDinsight partners with clients to generate and use rigorous evidence to improve social impact. Depending on client needs, we help diagnose systems, design and test potential solutions, and operationalize those solutions found to be most impactful.

We believe that client-centered, rigorous, and responsive evaluation is essential to help managers maximize program impact. Our team has collectively coordinated over 25 randomized evaluations in Africa and Asia, and works on-site with client organizations to efficiently answer important program questions.

For more information on IDinsight or this engagement, please contact Paul Wang (paul.wang@IDinsight.org) or visit www.IDinsight.org

Appendix

Description of evaluation activities

One Acre Fund was responsible for all aspects of planning and execution for this evaluation including: evaluation design, site randomization, farmer sampling, implementation of the loan intervention, survey tool development, data collection and verification, data cleaning, and data management.

IDinsight was engaged after these activities were completed to conduct an independent analysis of processed data from the three survey data sets sent by 1AF staff. Data analysis and a review of study limitations was carried out as detailed in this document and the associated limitations document ("One Acre Fund Mini-evaluation: Assessment of Evaluation Limitations"). To facilitate an understanding of the evaluation context and execution, IDinsight staff reviewed relevant 1AF study documents and engaged in conversations with 1AF program and evaluation staff. Additionally, IDinsight staff reviewed the raw data sets for the baseline and harvest surveys to investigate the data quality for variables included in this analysis.

Table 3. Baseline characteristic balance checks (Control vs Treatment)

	Control (n=203)		Treatment (n=210)		Difference
Baseline characteristic	*Mean*	*SD*	*Mean*	*SD*	*P-value*
Gender - Female (Binary - N, %)	111	54.7%	131	62.4%	0.11
Age	45.20	12.29	44.49	11.81	0.55
Household size	6.51	2.55	6.52	2.49	0.96
Highest level of education (by Mother or Father)	2.33	1.38	2.57	1.35	0.07*
Social connections (Number of people cited for agriculture advice)	1.65	1.19	1.41	1.42	0.07*
Total acres planting (2014)	1.29	0.77	1.38	.851	0.27
Total acres not planting (2014)	0.90	1.64	0.64	1.02	0.06*
Acres maize planting (2013)	1.09	1.80	1.16	1.81	0.69
Acres to rent (2014)	0.14	.343	0.20	.593	0.22
DAP (kg) (2013)	13.55	21.44	13.82	19.36	0.89
Can (kg) (2013)	11.13	26.23	9.43	17.36	0.44
2013 Maize harvest (kg)	447.50	579.84	382.733	480.57	0.22
Maize stored (kg)	156.66	201.65	143.80	188.12	0.50
Sales from food items in past month (KSH)	2002.22	4958.34	1529.43	6640.28	0.41
Sales from non-food items in past month (KSH)	1459.36	4154.33	657.95	2176.95	0.02**
Earnings from labor in past month (KSH)	746.06	2901.03	826.24	2939.90	0.78
Number of cows owned	1.92	2.18	2.12	1.97	0.32
Number of chickens owned	11.62	24.25	10.66	11.75	0.61
Number of mobile phones owned	1.71	1.04	1.67	.999	0.64
Loan amount for ag inputs (KSH) (2014)	2069.46	10316.36	433.69	1918.48	0.03**
Savings account with a bank (Binary - N, %)	50	24.6%	43	20.5%	0.31
Merry-go-round savings group (Binary - N, %)	170	83.7%	138	65.7%	<0.01***

Table 4. Baseline characteristic balance checks (Surveyed vs Lost to follow-up)

	Surveyed (n=413)		*Lost to follow-up (160)*		*Difference*
Baseline characteristic	*Mean*	*SD*	*Mean*	*SD*	*P-value*
Treatment group (Binary - N, %)	210	73.2%	77	26.8 %	.559
Control group (Binary - N, %)	203	71.0%	83	29.0%	-
Location					
Bugengi (N, %)	92	67.7%	44	32.3%	-
Elukongo (N, %)	111	74.0%	39	26.0%	-
Bumala (N, %)	77	93.9%	5	6.1%	-
Busibwabo (N, %)	52	80.0%	13	20.0%	-
Lung'a (N, %)	42	51.9%	39	48.1%	-
Nasira (N, %)	39	66.1%	20	33.9%	-
Gender - Female (Binary - N, %)	242	58.6%	88	55.0%	0.44
Age	44.83	12.04	44.68	13.05	0.90
Household size	6.52	2.52	6.62	2.71	0.68
Highest level of education (by Mother or Father)	2.45	1.37	2.47	1.40	0.90
Social connections (Number of people cited for agriculture advice)	1.53	1.31	1.49	1.28	0.74
Total acres planting (2014)	1.33	0.81	1.33	0.82	0.98
Total acres not planting (2014)	0.77	1.37	0.86	1.24	0.45
Acres maize planting (2013)	1.12	1.80	1.18	2.09	0.77
Acres to rent (2014)	0.17	0.49	0.23	0.51	0.19
DAP (kg) (2013)	13.69	20.39	13.89	24.92	0.93
Can (kg) (2013)	10.27	22.16	9.38	22.25	0.67
2013 Maize harvest (kg)	414.57	532.02	382.16	591.52	0.55
Maize stored (kg)	150.12	194.76	125.04	193.63	0.17
Sales from food items in past month (KSH)	1761.82	5871.76	1008.25	2517.42	0.03**
Sales from non-food items in past month (KSH)	1051.86	3318.80	1438.44	4527.40	0.33
Earnings from labor in past month (KSH)	786.83	2917.59	1728.13	5547.83	0.04**
Number of cows owned	2.02	2.08	1.95	2.04	0.72
Number of chickens owned	11.13	18.94	10.39	11.57	0.57
Number of mobile phones owned	1.69	1.02	1.81	1.06	0.21
Loan amount for ag inputs (KSH) (2014)	1237.71	7397.15	1090.94	8450.41	0.85
Savings account with a bank (Binary - N, %)	93	22.5%	49	30.1%	0.04**

Merry-go-round savings group (Binary - N, %)	308	74.6%	130	81.3%	0.09*

Table 5. Baseline characteristic balance checks for treatment group (full data vs partial data)

	Full data (n=159)		*Partial data (n=51)*		*Difference*
Baseline characteristic	*Mean*	*SD*	*Mean*	*SD*	*P-value*
Location					
Bugengi (N, %)	-	-	-	-	-
Elukongo (N, %)	-	-	-	-	-
Bumala (N, %)	61	38.4%	16	31.4%	-
Busibwabo (N, %)	28	17.6%	24	47.1%	-
Lung'a (N, %)	35	22.0%	7	13.7%	-
Nasira (N, %)	35	22.0%	4	7.8%	-
Gender - Female (Binary - N, %)	102	64.2%	29	56.9%	0.35
Age	44.51	0.95	44.43	1.58	0.97
Household size	6.23	0.19	7.45	0.34	<0.01***
Highest level of education (by Mother or Father)	2.60	0.11	2.47	0.17	0.51
Social connections (Number of people cited for agriculture advice)	1.37	0.11	1.55	0.19	0.43
Total acres planting (2014)	1.36	0.07	1.41	0.12	0.72
Total acres not planting (2014)	0.64	0.09	0.65	0.13	0.91
Acres maize planting (2013)	1.04	0.06	1.52	0.48	0.32
Acres to rent (2014)	0.19	0.05	0.23	0.07	0.71
DAP (kg) (2013)	14.19	1.60	12.65	2.31	0.58
Can (kg) (2013)	10.09	1.48	7.37	1.74	0.24
2013 Maize harvest (kg)	399.82	42.04	329.45	37.97	0.22
Maize stored (kg)	140.48	14.75	165.14	28.65	0.45
Sales from food items in past month (KSH)	1272.83	346.93	2329.41	1552.81	0.51
Sales from non-food items in past month (KSH)	823.40	195.77	142.16	61.78	<0.01***
Earnings from labor in past month (KSH)	963.59	262.25	398.04	161.14	0.07*
Number of cows owned	2.11	0.16	2.15	0.28	0.88
Number of chickens owned	10.36	0.79	11.59	2.28	0.61
Number of mobile phones owned	1.63	0.07	1.78	0.15	0.36
Loan amount for ag inputs (KSH) (2014)	426.41	150.00	456.37	282.80	0.92
Savings account with a bank (Binary - N, %)	34	21.4%	9	17.6%	0.57

Merry-go-round savings group (Binary - N, %)	109	68.6%	29	56.9%	0.13

Equation 1. Average land type yield calculation

$$\text{Land conversion factor estimate: } 40\ m^2 = \frac{1}{100}\ acre$$

$$Average\ land\ type_{\ x}\ yield\ (kg/acre) = \frac{(sample\ weight\ A_x\ (kg) +\ sample\ weight\ B_x\ (kg))}{2}\ x\ \frac{100m^2}{1\ acre}$$

Equation 2. Farmer weighted average yield

$$Farmer\ weighted\ average\ yield\ (kg) = \frac{(land\ yield_x\ (kg) *\ land\ size_x\ (acres)) + (land\ yield_{x+1}(kg) *\ land\ size\ _{x+1}(acres))}{(land\ size_x(acres) +\ land\ size_{x+1}(acres))}$$

Table 6. Farmer-level analysis on average treatment effect for maize yields using the clustered sandwich estimator for standard errors

	Without covariates (N=413)			*With covariates (N=413)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**368.31**	**0.07***	**[-38.59, 775.20]**	**368.54**	**0.05****	**[9.60, 727.47]**
Age				-2.21	0.22	[-6.28, 1.86]
Household size				8.35	0.45	[-17.67, 34.37]
Education						
Did not finish primary				*Ref*		
Finished primary				-47.26	0.32	[-158.53, 64.02]
Some secondary				-30.87	0.53	[-148.18, 86.44]
Finished secondary				-110.44	0.06	[-225.15, 4.28]
Beyond secondary				-28.82	0.75	[-245.39, 187.76]
Social connections				-4.32	0.89	[-78.47, 69.83]
Planting land size (acres)				59.59	0.33	[-82.65, 201.83]
Amount earned from selling food items (KSH)				-0.02	0.02**	[-0.04, -0.00]
Agriculture loan amount received (KSH)				0.00	0.52	[-0.01, 0.01]
Probability of being part of a savings group				28.54	0.75	[-189.26, 246.33]
2013 Maize production (kg)				0.09	0.05**	[-0.00, 0.18]
_cons	1164.76	<0.01***	[864.26, 1465.26]	1140.36	<0.01***	[877.54, 1403.18]

****Statistically significant at p < .01 level*
***Statistically significant at p < .05 level*
**Statistically significant at p < .10 level*
Note: Standard errors are clustered at the level of randomization (sub_location) using the clustered sandwich estimator

Table 7. Plot-level analysis on average treatment effect for yields for farmers with only one land type using wild cluster bootstrap-t method for standard errors

	Without covariates (N=281)			*With covariates (N=281)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control land	*Ref*			*Ref*		
1AF land	**466.88**	**0.09***	**[-65.60,999.35]**	**502.46**	**0.06***	**[-21.30, 1026.23]**
Age				-1.42	0.55	[-6.13, 3.29]
Household size				19.23	0.16	[-7.41, 45.87]
Education						
Did not finish primary				*Ref*		
Finished primary				-46.62	0.47	[-174.27, 81.03]
Some secondary				-37.54	0.62	[-185.63, 110.56]
Finished secondary				-144.49	0.09*	[-309.30, 20.31]
Beyond secondary				-78.27	0.47	[-291.71, 135.17]
Social connections				-34.72	0.20	[-88.14, 18.70]
Planting land size (acres)				117.17	0.26	[-88.77, 323.10]
Amount earned from selling food items (KSH)				-0.02	0.26	[-0.06, 0.02]
Agriculture loan amount received (KSH)				0.00	0.51	[-0.01, 0.01]
Probability of being part of a savings group				52.93	0.57	[-132.48, 238.34]
2013 Maize production (kg)				0.07	<0.01***	[0.07, 0.07]
_cons	1168.22	0.51	[-2325.25, 4661.69]	1012.61	<0.01***	[1012.61,1012.61]

****Statistically significant at p < .01 level*
***Statistically significant at p < .05 level*
**Statistically significant at p < .10 level*
Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

Table 8. Plot-level analysis on average treatment effect for yields for farmers with only one land type using the clustered sandwich estimator for standard errors

	Without covariates (N=281)			*With covariates (N=281)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control land	*Ref*			*Ref*		
1AF land	**466.88**	**0.03****	**[74.75,859.00]**	**502.46**	**0.02****	**[107.81, 897.11]**
Age				-1.42	0.53	[-6.82, 3.97]
Household size				19.23	0.07*	[-1.88, 40.34]
Education						
Did not finish primary				*Ref*		
Finished primary				-46.62	0.51	[-217.52, 124.28]
Some secondary				-37.54	0.64	[-230.50, 155.43]
Finished secondary				-144.49	0.04	[-281.56, -7.43]
Beyond secondary				-78.27	0.55	[-389.85, 233.30]
Social connections				-34.72	0.21	[-96.64, 27.20]
Planting land size (acres)				117.17	0.06*	[-8.08, 242.41]
Amount earned from selling food items (KSH)				-0.02	0.02**	[-0.04, -0.01]
Agriculture loan amount received (KSH)				0.00	0.41	[-0.01, 0.01]
Probability of being part of a savings group				52.93	0.70	[-282.56, 388.42]
2013 Maize production (kg)				0.07	0.03**	[0.01, 0.12]
_cons	1168.22	<0.01***	[862.20,1474.23]	1012.61	<0.01***	[721.02, 1304.21]

****Statistically significant at p < .01 level*

***Statistically significant at p < .05 level*

**Statistically significant at p < .10 level*

Note: Standard errors are clustered at the level of randomization (sub_location) using the clustered sandwich estimator

Table 9. Main regression analysis on average treatment effect for yields including only farmers with full maize yield data

	Without covariates (N=362)			*With covariates (N=362)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**412.92**	**0.14**	**[-133.58, 959.41]**	**413.99**	**0.06***	**[-14.42, 842.39]**
Age				-2.20	0.19	[-5.49, 1.10]
Household size				14.98	0.25	[-10.35, 40.31]
Education						
Did not finish primary				*Ref*		
Finished primary				-34.49	0.57	[-152.42, 83.43]
Some secondary				-9.74	0.84	[-103.46, 83.98]
Finished secondary				-112.92	0.23	[-297.26, 71.42]
Beyond secondary				-1.74	0.89	[-27.48, 24.01]
Social connections				-11.88	0.67	[-66.83, 43.07]
Planting land size (acres)				83.61	0.39	[-105.63, 272.86]
Amount earned from selling food items (KSH)				-0.02	0.23	[-0.06, 0.01]
Agriculture loan amount received (KSH)				0.00	0.51	[-0.01, 0.01]
Probability of being part of a savings group				22.86	0.75	[-116.54, 162.25]
2013 Maize production (kg)				0.08	<0.01***	[0.08, 0.08]
_cons	1164.76	0.51	[-2315.96, 4645.48]	1082.06	<0.01***	[1082.06, 1082.06]

****Statistically significant at p < .01 level*

***Statistically significant at p < .05 level*

**Statistically significant at p < .10 level*

Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

Table 10. Bounds analysis on average treatment effect for yields accounting for farmers lost to follow-up

	Lower bound (N=570)[β]			*Upper bound (N=570)*[δ]		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**-191.63**	**0.42**	**[-658.06, 274.79]**	**702.99**	**<0.01*****	**[702.99, 702.99]**
Age	-5.42	0.11	[-12.15, 1.32]	0.26	0.84	[-2.29, 2.82]
Household size	15.09	0.21	[-8.48, 38.66]	0.94	0.85	[-8.87, 10.75]
Education						
Did not finish primary	*Ref*			*Ref*		
Finished primary	23.97	0.59	[-63.13, 111.06]	-66.34	0.11	[-148.78, 16.10]
Some secondary	-63.68	0.35	[-196.14, 68.79]	-6.74	0.87	[-84.84, 71.36]
Finished secondary	-1.75	0.94	[-48.90, 45.40]	-141.16	<0.01***	[-229.65, -52.67]
Beyond secondary	47.82	0.50	[-90.18, 185.83]	-51.10	0.59	[-235.03, 132.83]
Social connections	-1.91	0.92	[-38.44, 34.62]	-4.30	0.74	[-29.75, 21.14]
Planting land size (acres)	14.74	0.69	[-58.50, 87.98]	71.25	0.23	[-44.99, 187.49]
Amount earned from selling food items (KSH)	-0.01	<0.01***	[-0.02, -0.00]	-0.01	0.08*	[-0.03, 0.00]
Agriculture loan amount received (KSH)	0.00	0.51	[-0.00, 0.00]	0.00	0.51	[-0.00, 0.01]
Probability of being part of a savings group	-139.32	0.22	[-361.32, 82.67]	114.48	0.06*	[-3.98, 232.94]
2013 Maize production (kg)	0.04	0.51	[-0.08, 0.16]	0.09	<0.01***	[0.09, 0.09]
_cons	1696.88	<0.01***	[1696.88, 1696.88]	846.53	<0.01***	[846.53, 846.53]

****Statistically significant at p < .01 level*

***Statistically significant at p < .05 level*

**Statistically significant at p < .10 level*

Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

[β] The lower bound model estimates the average treatment effect with attrited treatment farmers achieving yields at the 10th percentile level (575 kg/acre) and attrited control farmers achieving yields at the 90th percentile level (2475 kg/acre).

[δ] The upper bound model estimates the average treatment effect with attrited treatment farmers achieving yields at 90th percentile level (2475 kg/acre) and attrited control farmers achieving yields at the 10th percentile level (575 kg/acre).

One Acre Fund Evaluation:

Assessment of Evaluation Limitations

Prepared for:	*Andrew Youn, Executive Director & Founder*
	Kim Siegel, M&E Director
Date:	*February 27, 2015*

An accompanying document to "One Acre Fund Program Evaluation: Analysis and Results"

Context for engagement

The impact evaluation depicted in this document was designed and executed by One Acre Fund. IDinsight was engaged by One Acre Fund as an external impact advisor after data collection was complete. IDinsight reviewed the evaluation design and analyzed the study data. This document contains IDinsight's assessment of study limitations and their implications. The perspectives in this document are IDinsight's based solely on analysis of data provided by One Acre Fund and an assessment of the technical merits of the study design.[1] A separate, accompanying document that describes in detail the analysis and interpretation of findings was also created as part of this engagement.

Overview

The purpose of this document is to help One Acre Fund (1AF) appropriately communicate takeaways from their "mini" impact evaluation in Busia, Kenya within the context of the strengths and weaknesses in the evaluation methodology and execution.

Table 1: Summary of potential limitations examined

Potential limitation	*Description*	*Takeaway*
1. Small number of clusters	Six clusters (4 treatment, 2 control) were included in the evaluation.	The small sample size increases the margin of error / uncertainty about the impact magnitude and presents a challenge to generalizing these results across the population of farmers.
2. High level of attrition	Maize yield data could not be collected for 28% of sampled farmers.	The magnitude of attrition and baseline characteristics of attrited households is similar across groups. Potential unknown determinants of attrition, however, present uncertainty about possible biases. We do not have any reason to believe that attrition invalidates the main takeaway of this analysis (that the impact of the 1AF program may have been positive and large), but it does increase the margin of error / uncertainty about impact magnitude.

[1] See Appendix for a description of the evaluation activities completed by each organization.

3. Incomplete treatment yield data	For 24% of surveyed treatment farmers, maize yield data was not collected for all sampled land types.	In some cases, treatment farmers cultivated land with 1AF inputs and land without 1AF inputs, meaning two maize yields should be reported. However, only 1 maize yield was collected for 51 of these farmers. A secondary analysis omitting these farmers indicated a large increase in the average treatment effect, which suggests that these farmers likely have lower yields compared to the rest of the treatment group. Balance checks within the treatment group indicate little reason to believe there are systematic differences between these farmers and the rest of the treatment group. These farmers are included in the analysis, but represent further uncertainty about the missing yield data and attrited farmers in general.
4. Control group selection and benefits	1AF revoked treatment from the control group after fees were paid and provided significant compensation to control farmers, which may have affected control farmer yields.	Control sample selection and the compensation of control group farmers could have biased the average treatment effect in either direction. We do not think there is reason to believe that these biases impacted the estimates enough to change the direction of the impact, but this possibility cannot be definitively ruled out.
5. Limitations in the research protocol	1AF conducted this evaluation in-house with staff knowledgeable of treatment group assignment collecting data. No formal protocol or analysis plan was established prior to the study implementation.	It is possible that outcomes were influenced – intentionally or not – by 1AF staff. From conversations with 1AF staff, this does not appear to have occurred, however smaller unintentional differences in data collection or implementation at the farmer level could have affected the difference in yields.
6. Intercropping	A significantly higher percentage of control farmers (67%) practiced intercropping on their maize land compared to the control farmers (15%).	The practice of intercropping could bias maize yield estimates if this altered planted maize densities. Conversations with 1AF staff indicate that this is unlikely to be the case. Additionally, this could affect the interpretation of results if intercropping acts as a mediator for 1AF program impact or if profits are sacrificed from not intercropping. Ultimately, we do not think that intercropping has a large effect on maize yields (which is the focus of this analysis), but we recommend accounting for intercropping if 1AF seeks to estimate the effect of the program on farm-level profits.

Background

One Acre Fund (1AF) conducted an evaluation in Western Kenya in 2014 to examine the impact of their inputs on loan program to small scale maize farmers. Six new program sites in Busia, Kenya were randomly allocated to be treatment (n=4) or control (n=2) sites for the purposes of measuring impact. Farmers in the treatment sites received seed and fertilizer on credit in addition to training. Farmers in the control sites were provided with mobile phones, bed nets, chlorine water treatment, and health and funeral insurance for one year.

1AF conducted three surveys for this evaluation, including a baseline survey on household characteristics and 2013 crop production levels at the beginning of the season, a crop-mix survey on the planted land and inputs used for the current season after planting, and a harvest survey on the yields for study farmers at the end of the season. Yield measurements for each farmer were collected by 1AF staff members, who harvested and weighed maize from 2 randomly selected land samples[2] (each 8m x 5m) for each type of land (1AF and non-1AF). 1AF evaluation staff was responsible for verifying, compiling, and cleaning all survey data.

IDinsight was engaged by 1AF after all intervention and data collection activities were complete.

Limitations

This document describes the main potential limitations associated with mini evaluation and data analysis with the goals of:

1. Assessing the limitations of the research.
2. Informing how to accurately and effectively communicate and use the research results.

We recognize that some limitations are due to the original operational (as opposed to rigorous impact measurement) objective of the evaluation. Overall, we hope this document will provide the proper context for the interpretation of results from this study.

1. Small number of clusters

Context: Six sites were included in the evaluation, with four sites randomly allocated to receive the intervention and two sites selected as comparison sites.

Discussion: Large numbers are required for a representative population sample and for randomization to reliably minimize differences between treatment and comparison groups that may affect the outcome. By randomizing on so few clusters, there is a high possibility of underlying differences between the treatment and control households, and therefore more uncertainty around the impact estimate.

Treatment and control group balance: The treatment and control groups had few statistically significant differences across key baseline characteristics, including reported maize production in the previous year (Appendix Table 2). We do not think these differences are substantial enough to meaningfully bias estimates. The primary analysis also uses a regression that controls for key observable characteristics which helps reduce this possibility. Unobserved underlying differences across the groups may still cause bias, but balance among observable characteristics supports the argument that unobservable characteristics are also balanced.

We cannot rule out the possibility that non-intervention shocks affected one group more than the other after the baseline. In interviews, 1AF staff have not reported detecting any such shock that could have affected maize yields.

[2] IDinsight did not assess the procedure used to randomly select the plot samples.

The susceptibility of the small sample size to the consequences of a post-baseline shock remains a limitation, but we think the likelihood of a large shock unrecognized by 1AF staff is small.

Takeaway: It is unlikely that biases due to undetected imbalances across the treatment and control groups invalidate the point estimate. Any bias would have to be relatively large in the positive direction for this to be the case, and we have no strong indication of the presence of any bias or any likely direction of bias. However, we recommend that 1AF not make strong claims about the intervention's impact magnitude. The small sample size makes study outcomes challenging to generalize and, furthermore, even small biases in the positive direction could mean that the intervention's true impact is materially smaller than estimated.

2. *High level of attrition*

Context: 1AF randomly selected 287 treatment farmers and 286 control farmers out of 1,141 farmers surveyed at baseline to collect maize harvest data. Of these farmers, maize production data was successfully collected from 210 (73%) treatment farmers and 203 (71%) control farmers.

Discussion: Sizable attrition that differentially affects one group compared to the other can introduce bias. Depending on the distribution of production across farmers, attrition that leads to a systematic under-representation of a certain type of a farmer can also introduce bias.

The percentage of farmers with no harvest data information was similar --27% for the treatment group and 29% for the control group. Thus, differences in attrition *magnitude* will not produce meaningful bias. However, even if attrition magnitude is similar across both groups, the impact estimate may no longer be relevant for farmers who dropped out, and the study power is reduced.

Attrition was most frequently attributed to 1AF staff's inability to reach farmers prior to their maize harvesting time. There is no reason to think that this dynamic differed across treatment and control groups, so attrition likely affected the make-up of each treatment group similarly.

It is still possible that the farmers who dropped out tend to share different characteristics from surveyed farmers that would bias the impact estimate. A potential scenario is if farmers in the treatment group dropped out because they were not realizing gains from the program while control farmers randomly dropped out. In this case we might overestimate the treatment effect.

Balance checks using the baseline data to make comparisons between treatment and control groups (Appendix Table 2) and surveyed and lost to follow-up groups (Appendix Table 3) affirmed that there were few significant differences in observed characteristics between groups. Additionally, a bounds analysis for attrition imputing yield data for farmers lost to follow-up based on the 10^{th} and 90^{th} percentile yield figures indicate probable improvements among treatment farmers compared to control farmers, but the lower bound indicates a possibility of no treatment effect (Appendix Table 4).

Takeaway: The high attrition rate (28%) is a cause for concern, but attrition magnitude appeared to affect both groups equally and analyses of the characteristics of surveyed farmers versus those lost to follow-up did not indicate undue risk of bias. It is possible that attrition has introduced some bias but, on its own, is unlikely to invalidate directional takeaways of the primary analysis. The high attrition rate does, however, reduce the validity of the study findings for the greater farmer population.

3. *Incomplete treatment yield data*

Context: In some cases, treatment farmers did not receive sufficient 1AF inputs to cover their entire maize land. As such, yield data for these farmers was collected for the land cultivated with 1AF inputs *and* land cultivated without 1AF inputs. These yield measurements were used to calculate a weighted average maize yield for the farmer, which was the primary outcome for this study. However, 51 treatment farmers (24% of surveyed treatment farmers) who were expected to have two yield measurements only had one yield measurement. 94% of the yield data for these 51 farmers was collected from land receiving 1AF inputs.

Discussion: The issue of incomplete maize yield data differentially affects the treatment group farmers, though this was expected given treatment farmers are more likely to have multiple types of land (land cultivated with 1AF inputs and land cultivated without 1AF inputs).

The weighted average maize yield for each farmer was chosen to mitigate the possibility that a treatment farmer's decision about which land to cultivate with 1AF inputs biases the average treatment effect estimate. If the yield measurement for a farmer's secondary plot, which did not receive 1AF inputs, was omitted from the analysis, this may similarly bias the average treatment effect estimate. Additionally, if the 51 farmers with missing maize yield data tend to share different characteristics from the rest of the sample, this could bias the average treatment effect in either direction. The missing data was most likely attributable to 1AF's inability to conduct the harvest survey prior to the maize harvest.

A secondary analysis using the main regression model but omitting these farmers indicated a large increase in the average treatment effect compared to the primary analysis (Appendix Table 6). This suggests that there may be systematic differences among these farmers with missing data. Balance checks between the 51 farmers with incomplete maize yield data and the remaining treatment group indicated few major differences between the two groups across relevant baseline indicators (Appendix Table 5). Ultimately, these farmers were included in the primary analysis with average yields from the remaining treatment farmers used to estimate the missing data. The missing data and difference in average treatment effect size from the secondary analysis does cause uncertainty around this missing data.

Takeaway: As with the sample attrition, missing yield data for 24% of the surveyed treatment farmers is concerning. A secondary regression analysis omitting these farmers indicated a significantly larger average treatment effect suggesting the possibility of a systematic difference among these farmers.

Balance checks comparing these farmers to the rest of the treatment group indicated few differences in baseline characteristics. Ultimately, these farmers were included in the analysis with yield adjustments based on yield data from treatment farmers, however this limitation causes further uncertainty around missing data and attrited farmers.

4. Control group selection and benefits

Context: Farmers in the two control regions who had already paid fees for the program were told they would receive the program in the following year and instead provided with a mobile phone, bed net, chlorine water treatment, one year of health insurance, and one year of funeral insurance all free of charge. The monetary value of these gifts was approximately 4,500 Ksh.

Discussion: The withholding of the 1AF program and provision of goods to control group farmers could bias the experiment in two ways:

First, if these items provided control group farmers with more security, lower household costs, or a connection to markets, this may have positively impacted maize productivity leading to an underestimate of the treatment effect. Alternatively, if farmers' motivation to tend to their fields decreased because of a sense of security from the items received, this may have negatively impacted maize productivity leading to an overestimate of the treatment effect.

Second, delaying the program for farmers who have made monetary commitments could also have altered control farmer planning and expectations for the current year. If farmers suffered from lack of access to inputs or inefficient harvest planning because of this revoked offer, we would expect to see an overestimate of treatment farmer yields. Additionally, an underestimate may occur if control farmers had intentionally lower yields to demonstrate a future need for the inputs. The selection of farmers in this manner mitigated the bigger limitation of a selection bias that would have rendered the treatment groups incomparable, but still presents limitations based on how farmers reacted to the program delay.

Takeaway: The control group compensation and selection process present a potential positive or negative bias on control group yields. We do not think there is any reason to believe these biases significantly impacted the outcome, but the accuracy and direction of these biases cannot be determined and provide further uncertainty around yield differences between groups.

5. Limitations in the research protocol

Context: This RCT was implemented in-house with 1AF staff conducting data collection and analysis. To our knowledge, there was no formal protocol established ahead of the implementation, and 1AF enumerators were aware of each farmer's treatment group assignment during data collection.

Discussion: Transparency is essential to ensure biases are avoided. Establishing a formal protocol and analysis plan prior to the study addresses the possibility that adjustments were made to the intervention during implementation to drive a treatment effect. 1AF does not believe this is a large risk, but it cannot be ruled out without more detailed documentation.

For services such as 1AF's, internal data collection presents the possibility that beneficiaries adjust their survey responses or interactions to appease 1AF staff. This is especially possible for control farmers who had the program delayed.

1AF's yield data collection process was highly managed by 1AF staff with sample harvesting and weighing done with the farmer. However, the enumerator knowledge of treatment group assignment could have impacted harvest or survey data collection through a difference – whether intentional or not – in survey implementation between groups for the similar goal of demonstrating a treatment effect for 1AF.

Overall, the net directional effect of such potential biases is difficult to hypothesize without close involvement in data collection, however these biases cannot be ruled out as possibilities.

Takeaway: Internal evaluations such as this one present challenges regarding how beneficiaries respond to program staff conducting surveys. The absence of a published protocol increases the possibility of biases being introduced via data collection and program implementation. Balance checks suggest that no such biases occurred that would heavily impact the outcomes, but this possibility cannot be ruled out.

6. Uncertainty due to intercropping

Context: Planting maize with other crops on the same plot, or intercropping, is a common practice in Western Kenya among smallholder farmers. 1AF has noticed historically higher gains to their intervention in the absence of this technique and therefore opted to train farmers to not intercrop. As such, a higher percentage of control farmers intercropped their maize (67%) as compared to treatment farmers (15%).

Discussion: Because 1AF trains farmers not to intercrop, the difference in the percentage of farmers in each group who implemented this technique is not surprising. However, it does present several limitations that are worth mentioning.

First, the practice of intercropping can take many different forms. If, for example, this practice results in a different density of maize planted, this would cause a bias in the yield measurement technique. On the other hand, if intercropping has positive spillover factors for maize, this would cause an underestimate of the yield impact. 1AF has indicated that the majority of farmers do not alter their maize densities when intercropping, however this has not been verified for each farmer, who may use different specifications when intercropping.

Secondly, the absence of intercropping necessarily means that available land is not being cultivated, which represents a loss of potential profits. Maize farmers most frequently intercrop using beans. 1AF has indicated that they train against intercropping because the intervention's gains to maize cultivation without intercropping are greater than the profit generated from the intercropped beans. This analysis focuses on maize yields as the primary outcome, not farm profitability, and therefore does not adjust for the difference in intercropping between groups. The issue should however be considered in the broader assessment of the program's impact on farm profitability.

Lastly, the high prevalence of intercropping among the control group compared to the treatment group indicates the possibility that the absence of intercropping acts as a mediator for the intervention's impact – meaning the demonstrated impact is due mainly to the absence of intercropping rather than the loan package provided by 1AF. We think this is unlikely given that farmers in the control group experience higher yields due to intercropping, but cannot completely rule this out.

Takeaway: Ultimately the difference in intercropping is an outcome of 1AF's intervention and thus likely does not present a major limitation to the results of this study. The issue should be more closely studied in future research as differences in profits could be dependent on the farmer's local market context and household consumption habits.

About IDinsight

IDinsight partners with clients to generate and use rigorous evidence to improve social impact. Depending on client needs, we help diagnose systems, design and test potential solutions, and operationalize those solutions found to be most impactful.

We believe that client-centered, rigorous, and responsive evaluation is essential to help managers maximize program impact. Our team has collectively coordinated over 25 randomized evaluations in Africa and Asia, and works on-site with client organizations to efficiently answer important program questions.

For more information on IDinsight or this engagement, please contact Paul Wang (paul.wang@IDinsight.org) or visit www.IDinsight.org

Appendix

Table 2. Baseline characteristic balance checks (Control vs Treatment)

	Control (n=203)		*Treatment (n=210)*		*Difference*
Baseline characteristic	*Mean*	*SD*	*Mean*	*SD*	*P-value*
Gender - Female (Binary - N, %)	111	54.7%	131	62.4%	0.11
Age	45.20	12.29	44.49	11.81	0.55
Household size	6.51	2.55	6.52	2.49	0.96
Highest level of education (by Mother or Father)	2.33	1.38	2.57	1.35	0.07*
Social connections (Number of people cited for agriculture advice)	1.65	1.19	1.41	1.42	0.07*
Total acres planting (2014)	1.29	0.77	1.38	.851	0.27
Total acres not planting (2014)	0.90	1.64	0.64	1.02	0.06*
Acres maize planting (2013)	1.09	1.80	1.16	1.81	0.69
Acres to rent (2014)	0.14	.343	0.20	.593	0.22
DAP (kg) (2013)	13.55	21.44	13.82	19.36	0.89
Can (kg) (2013)	11.13	26.23	9.43	17.36	0.44
2013 Maize harvest (kg)	447.50	579.84	382.733	480.57	0.22
Maize stored (kg)	156.66	201.65	143.80	188.12	0.50
Sales from food items in past month (KSH)	2002.22	4958.34	1529.43	6640.28	0.41
Sales from non-food items in past month (KSH)	1459.36	4154.33	657.95	2176.95	0.02**
Earnings from labor in past month (KSH)	746.06	2901.03	826.24	2939.90	0.78
Number of cows owned	1.92	2.18	2.12	1.97	0.32
Number of chickens owned	11.62	24.25	10.66	11.75	0.61
Number of mobile phones owned	1.71	1.04	1.67	.999	0.64
Loan amount for ag inputs (KSH) (2014)	2069.46	10316.36	433.69	1918.48	0.03**
Savings account with a bank (Binary - N, %)	50	24.6%	43	20.5%	0.31
Merry-go-round savings group (Binary - N, %)	170	83.7%	138	65.7%	<0.01***

Table 3. Baseline characteristic balance checks (Surveyed vs Lost to follow-up)

Baseline characteristic	*Surveyed (n=413)* *Mean*	*SD*	*Lost to follow-up (160)* *Mean*	*SD*	*Difference* *P-value*
Treatment group (Binary - N, %)	210	73.2%	77	26.8 %	.559
Control group (Binary - N, %)	203	71.0%	83	29.0%	-
Location					
Bugengi (N, %)	92	67.7%	44	32.3%	-
Elukongo (N, %)	111	74.0%	39	26.0%	-
Bumala (N, %)	77	93.9%	5	6.1%	-
Busibwabo (N, %)	52	80.0%	13	20.0%	-
Lung'a (N, %)	42	51.9%	39	48.1%	-
Nasira (N, %)	39	66.1%	20	33.9%	-
Gender - Female (Binary - N, %)	242	58.6%	88	55.0%	0.44
Age	44.83	12.04	44.68	13.05	0.90
Household size	6.52	2.52	6.62	2.71	0.68
Highest level of education (by Mother or Father)	2.45	1.37	2.47	1.40	0.90
Social connections (Number of people cited for agriculture advice)	1.53	1.31	1.49	1.28	0.74
Total acres planting (2014)	1.33	0.81	1.33	0.82	0.98
Total acres not planting (2014)	0.77	1.37	0.86	1.24	0.45
Acres maize planting (2013)	1.12	1.80	1.18	2.09	0.77
Acres to rent (2014)	0.17	0.49	0.23	0.51	0.19
DAP (kg) (2013)	13.69	20.39	13.89	24.92	0.93
Can (kg) (2013)	10.27	22.16	9.38	22.25	0.67
2013 Maize harvest (kg)	414.57	532.02	382.16	591.52	0.55
Maize stored (kg)	150.12	194.76	125.04	193.63	0.17
Sales from food items in past month (KSH)	1761.82	5871.76	1008.25	2517.42	0.03**
Sales from non-food items in past month (KSH)	1051.86	3318.80	1438.44	4527.40	0.33
Earnings from labor in past month (KSH)	786.83	2917.59	1728.13	5547.83	0.04**
Number of cows owned	2.02	2.08	1.95	2.04	0.72
Number of chickens owned	11.13	18.94	10.39	11.57	0.57
Number of mobile phones owned	1.69	1.02	1.81	1.06	0.21
Loan amount for ag inputs (KSH) (2014)	1237.71	7397.15	1090.94	8450.41	0.85
Savings account with a bank (Binary - N, %)	93	22.5%	49	30.1%	0.04**

Merry-go-round savings group (Binary - N, %)	308	74.6%	130	81.3%	0.09*

Table 4. Bounds analysis for attrition using 10^{th} and 90^{th} percentiles of yield

	Lower bound (N=570)[β]			***Upper bound (N=570)[δ]***		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**-191.63**	**0.42**	**[-658.06, 274.79]**	**702.99**	**<0.01*****	**[702.99, 702.99]**
Age	-5.42	0.11	[-12.15, 1.32]	0.26	0.84	[-2.29, 2.82]
Household size	15.09	0.21	[-8.48, 38.66]	0.94	0.85	[-8.87, 10.75]
Education						
Did not finish primary	*Ref*			*Ref*		
Finished primary	23.97	0.59	[-63.13, 111.06]	-66.34	0.11	[-148.78, 16.10]
Some secondary	-63.68	0.35	[-196.14, 68.79]	-6.74	0.87	[-84.84, 71.36]
Finished secondary	-1.75	0.94	[-48.90, 45.40]	-141.16	<0.01***	[-229.65, -52.67]
Beyond secondary	47.82	0.50	[-90.18, 185.83]	-51.10	0.59	[-235.03, 132.83]
Social connections	-1.91	0.92	[-38.44, 34.62]	-4.30	0.74	[-29.75, 21.14]
Planting land size (acres)	14.74	0.69	[-58.50, 87.98]	71.25	0.23	[-44.99, 187.49]
Amount earned from selling food items (KSH)	-0.01	<0.01***	[-0.02, -0.00]	-0.01	0.08*	[-0.03, 0.00]
Agriculture loan amount received (KSH)	0.00	0.51	[-0.00, 0.00]	0.00	0.51	[-0.00, 0.01]
Probability of being part of a savings group	-139.32	0.22	[-361.32, 82.67]	114.48	0.06*	[-3.98, 232.94]
2013 Maize production (kg)	0.04	0.51	[-0.08, 0.16]	0.09	<0.01***	[0.09, 0.09]
_cons	1696.88	<0.01***	[1696.88, 1696.88]	846.53	<0.01***	[846.53, 846.53]

****Statistically significant at $p < .01$ level*
***Statistically significant at $p < .05$ level*
**Statistically significant at $p < .10$ level*
Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

[β] The lower bound model estimates the average treatment effect with attrited treatment farmers achieving yields at the 10^{th} percentile level (575 kg/acre) and attrited control farmers achieving yields at the 90^{th} percentile level (2475 kg/acre).
[δ] The upper bound model estimates the average treatment effect with attrited treatment farmers achieving yields at 90^{th} percentile level (2475 kg/acre) and attrited control farmers achieving yields at the 10^{th} percentile level (575 kg/acre).

Table 5. Baseline characteristic balance checks for treatment group (Full data vs Partial data)

Baseline characteristic	*Full data (n=159)* Mean	*SD*	*Partial attrited (n=51)* Mean	*SD*	*Difference* P-value
Location					
Bugengi (N, %)	-	-	-	-	-
Elukongo (N, %)	-	-	-	-	-
Bumala (N, %)	61	38.4%	16	31.4%	-
Busibwabo (N, %)	28	17.6%	24	47.1%	-
Lung'a (N, %)	35	22.0%	7	13.7%	-
Nasira (N, %)	35	22.0%	4	7.8%	-
Gender - Female (Binary - N, %)	102	64.2%	29	56.9%	0.35
Age	44.51	0.95	44.43	1.58	0.97
Household size	6.23	0.19	7.45	0.34	<0.01***
Highest level of education (by Mother or Father)	2.60	0.11	2.47	0.17	0.51
Social connections (Number of people cited for agriculture advice)	1.37	0.11	1.55	0.19	0.43
Total acres planting (2014)	1.36	0.07	1.41	0.12	0.72
Total acres not planting (2014)	0.64	0.09	0.65	0.13	0.91
Acres maize planting (2013)	1.04	0.06	1.52	0.48	0.32
Acres to rent (2014)	0.19	0.05	0.23	0.07	0.71
DAP (kg) (2013)	14.19	1.60	12.65	2.31	0.58
Can (kg) (2013)	10.09	1.48	7.37	1.74	0.24
2013 Maize harvest (kg)	399.82	42.04	329.45	37.97	0.22
Maize stored (kg)	140.48	14.75	165.14	28.65	0.45
Sales from food items in past month (KSH)	1272.83	346.93	2329.41	1552.81	0.51
Sales from non-food items in past month (KSH)	823.40	195.77	142.16	61.78	<0.01***
Earnings from labor in past month (KSH)	963.59	262.25	398.04	161.14	0.07*
Number of cows owned	2.11	0.16	2.15	0.28	0.88
Number of chickens owned	10.36	0.79	11.59	2.28	0.61
Number of mobile phones owned	1.63	0.07	1.78	0.15	0.36
Loan amount for ag inputs (KSH) (2014)	426.41	150.00	456.37	282.80	0.92
Savings account with a bank (Binary - N, %)	34	21.4%	9	17.6%	0.57
Merry-go-round savings group (Binary - N, %)	109	68.6%	29	56.9%	0.13

Table 6. Main regression analysis on average treatment effect for yields including only farmers with full maize yield data

	Without covariates (N=362)			*With covariates (N=362)*		
Covariates	**Coefficient**	**P-value**	**[95% CI]**	**Coefficient**	**P-value**	**[95% CI]**
Treatment group						
Control farmers	*Ref*			*Ref*		
1AF farmers	**412.92**	**0.14**	**[-133.58, 959.41]**	**413.99**	**0.06***	**[-14.42, 842.39]**
Age				-2.20	0.19	[-5.49, 1.10]
Household size				14.98	0.25	[-10.35, 40.31]
Education						
Did not finish primary				*Ref*		
Finished primary				-34.49	0.57	[-152.42, 83.43]
Some secondary				-9.74	0.84	[-103.46, 83.98]
Finished secondary				-112.92	0.23	[-297.26, 71.42]
Beyond secondary				-1.74	0.89	[-27.48, 24.01]
Social connections				-11.88	0.67	[-66.83, 43.07]
Planting land size (acres)				83.61	0.39	[-105.63, 272.86]
Amount earned from selling food items (KSH)				-0.02	0.23	[-0.06, 0.01]
Agriculture loan amount received (KSH)				0.00	0.51	[-0.01, 0.01]
Probability of being part of a savings group				22.86	0.75	[-116.54, 162.25]
2013 Maize production (kg)				0.08	<0.01***	[0.08, 0.08]
_cons	1164.76	0.51	[-2315.96, 4645.48]	1082.06	<0.01***	[1082.06, 1082.06]

****Statistically significant at p < .01 level*

***Statistically significant at p < .05 level*

**Statistically significant at p < .10 level*

Note: Standard errors are clustered at the level of randomization (sub_location) using the wild cluster bootstrap-t method.

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