

# One Acre Fund

## Quality of Life Study in Kenya : Year 3 Results



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## ONE ACRE FUND - LONGITUDINAL QUALITY OF LIFE STUDY IN KENYA

### Executive Summary

For years, One Acre Fund has rigorously tested the impact of its program on harvest yields and profits of participating farmers. Back in 2015, the organization had less information on the ways in which the program was impacting other facets of farmers' lives. For example, we wanted to know: in what ways farmers invest their extra income if these investments lead to better life prospects, and how the program affects aspects like health, education, and nutritional status? To better understand the impact on farmers' lives, with a more holistic view, One Acre Fund initiated the first "Quality of Life" study in 2015.

**Methods.** This longitudinal study followed cohorts of One Acre Fund farmers in both Kenya and Rwanda (two of the largest country programs) and examined how outcomes across a broad section of their lives – including health, education, nutrition, and financial literacy – changed over time compared to changes which occurred for a control group in a similar adjacent area. In addition to this **difference-in-difference study** design, we used **propensity score matching** to control for any observable differences between program and control groups. Both techniques help us mitigate selection bias which comes from comparing farmers who self-selected into the program against those who have not.

**Data Collection:** From 2015 to 2018, data collection for this study was undertaken once each year during the annual hunger season. Due to the seasonal nature of some outcome areas, such as consumption and income, we also fielded a mid-cycle supplemental survey in November 2018, a few months after the harvest season. The aim of the supplemental survey was to give us additional insight into farmer behavior that would have otherwise been overlooked during the hunger season data collection. This report presents the results on these quality-of-life indicators after **three consecutive years of program participation in Kenya**. Due to study design issues in Rwanda including the violation of the parallel trends assumption<sup>1</sup>, program attrition, and issues with permits to conduct surveys related to human subjects, we had to discontinue the study in the country.

**Note on Presentation of Results:** For ease of presentation, we will often refer to the difference in difference results (i.e. the change noticed in One Acre Fund farmers in comparison to control farmers over the period of time from the baseline to the follow up round) interchangeably with "impact". We have reported differences that are statistically significant at  $p < .05$ , which are highlighted. This means there is a less than 5% chance these differences would be found by chance.

**Year 1 Results.** After one year of program participation in Kenya and Rwanda, One Acre Fund farmers saw a **significant increase in agricultural productivity and a decrease in hunger relative to controls in both countries** (lower impact seen in Rwanda likely due to poor bean seed germination in the study area). This translated into **an increase in livestock asset accumulation** by Kenyan farmers (none in Rwanda probably due to the lower harvest). Surprisingly, we did not see much increase in educational outcomes for the

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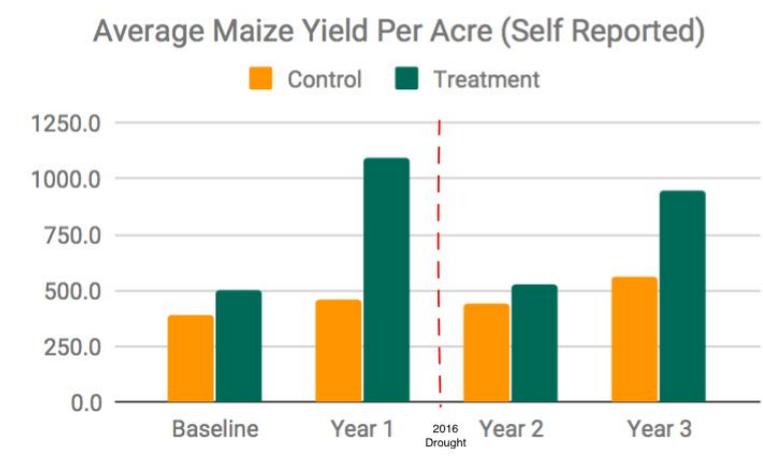
<sup>1</sup> The parallel trends assumption is one of the basic tenets of carrying out a DID estimation. It assumes that any external shock affects both groups in the same direction and similar magnitude. In Year 2, our qualitative analysis in Rwanda revealed that treatment and control sites faced dissimilar external shocks between 2016 and 2017 which could have varying impact on the quality of life outcomes for these two sites.

children in One Acre Fund households. In Kenya, this was likely due to the fact that baseline educational attendance was already quite high. Although there was **no change in consumption patterns in Kenya**; in Rwanda, we saw an **increase in the total consumption in the past two weeks as well as one year (from when the survey was conducted )** as compared to control farmers. This can probably be attributed to increased agricultural productivity, One Acre Fund farmers in Kenya and Rwanda also reported **relying less on non-agricultural income streams over the study period** (as compared to control farmers). A **higher share of children in One Acre Fund households were reported to be consuming nutritious food items** such as milk (in Kenya) as well as fish and meat (in Rwanda).

**Year 2 Results.** In 2016, we had some unique challenges that affected both our program’s ability to *generate* impact and the study’s ability to *detect* an impact, across both Kenya and Rwanda. The short and long rains in Kenya during the 2016 season (especially in Arid and Semi-Arid Lands (ASAL)) were below average. This resulted in severe drought which also had an adverse effect on crop yields that season. Busia, the site for this study, was particularly badly hit from drought-suffering from a large decrease in average maize yield per acre. As a result, we only found a comparatively small increase in maize yield per acre for One Acre Fund farmers in Kenya and none in Rwanda. These results were in sharp contrast to findings in the first year of the study (see above) in which we observed much higher increases in agricultural productivity. The first and foremost link in the theory of change is the impact on agricultural practices and yields for One Acre Fund farmers. When we **find a weak impact on the first link itself, it is very unlikely that we are able to have much impact on other quality of life outcomes** that take place as a result of higher harvests. Due to the unprecedented poor agricultural year and other study design issues, we did not find an increase in many of the secondary impact areas. However, we did find some evidence that program participation may have helped to cushion the blow of a difficult harvest year for treatment farmers in Kenya. We found evidence that One Acre Fund farmers used livestock asset gains made in the good agricultural year to be sold for consumption smoothing during the time of a drought shock.

**Year 3 Results.** In the final year, we only conducted the study in Kenya and investigated the impact on the complete range of quality of life outcomes after participation in the One Acre Fund program after three consecutive years. After a tough agricultural year in 2016, the Kenyan maize harvests bounced back during the 2017 season. As a result in the 2018 round of data collection (Year 3), we start to pick up the impact on more areas than the previous Year 2 round.

### Trends in maize productivity per acre

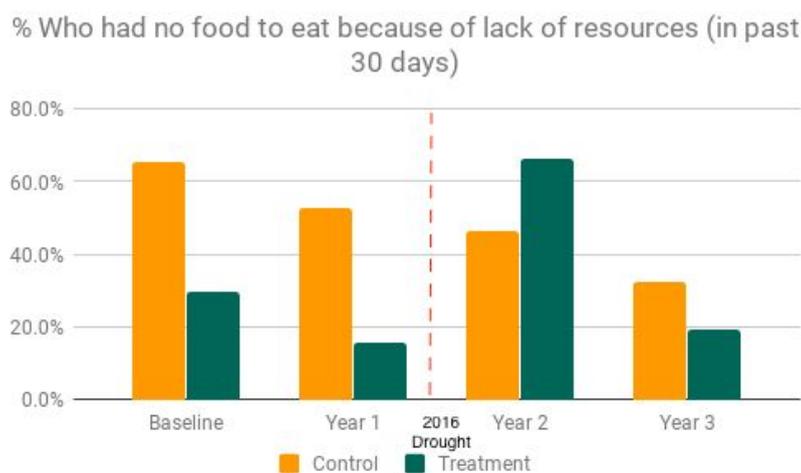


The graph above presents the summary findings from the analysis in Kenya. We find a relatively strong increase in maize productivity for One Acre Fund farmers - when both farmers self-reported and physically measured. This led to an increase in maize income by \$99.3 for One Acre Fund farmers in treatment areas compared to control farmers. When we look at percentage improvements for farmers, this represents a 39% increase in maize profit. One Acre Fund farmers also **increased the total area cultivated for agriculture** (top four crops) by 0.41 acres compared to control over all three years of the study. We note that the total area cultivated increased for every additional year of program participation, indicating that there were incremental benefits of each year of program participation towards the widening of the client’s agriculture base. The **higher harvests also translated into a higher likelihood of having a maize surplus during the hunger season.**

**One Acre Fund farmers increased their overall, physical and livestock assets value** compared to controls after three years of program participation. Looking at individual assets, this increase is largely driven by an **increase in ownership of solar lights, trees, and cows.** Over the three years of the study, we did not detect any impact on consumption in Kenya when we collected the data during the hunger season. However, the results from the short module added after harvest season showed that One Acre Fund actually had an impact on the **consumption of food in the past two days.** We believe this to be a more modest representation of our impact during the harvest period because One Acre Fund farmers might behave differently with the seasonal fluctuations than control farmers.

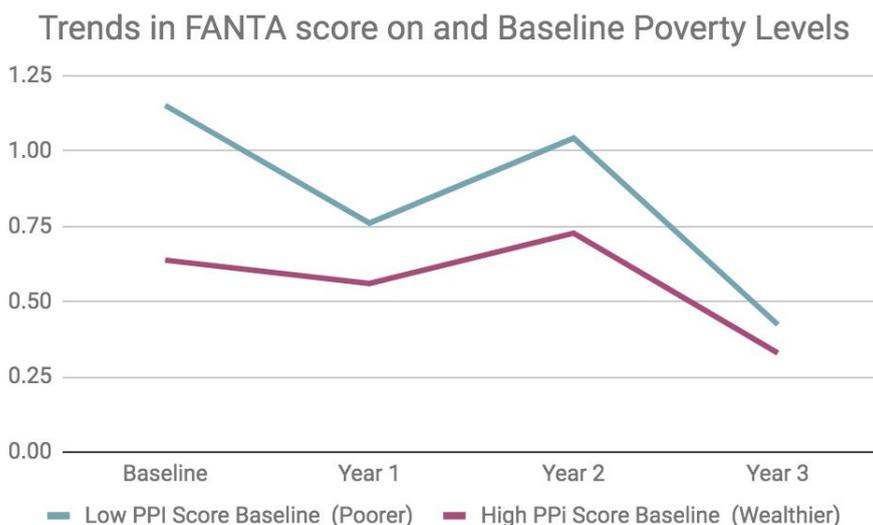
Surprisingly, we find evidence of a negative impact on hunger (measured through the FANTA score) for One Acre Fund farmers compared to controls. At the baseline, hunger levels for control farmers were already much higher than One Acre Fund farmers and after three years, controls still reported higher hunger than One Acre Fund farmers. **One Acre Fund farmers and control farmers experienced a decrease in hunger** over three years of the study. However, **control farmers had a much larger decrease in hunger than One Acre Fund farmers.** Looking at the graph below, it is clear that One Acre Fund reported hunger is in line with the harvests that season. In good harvest years, we see a dramatic decrease in hunger (like Year 1 and Year 3) and a spike in hunger levels during drought years (Year 2). However, we do not see the same trends in control farmers, which seems to suggest that there is some external threat to the validity of the parallel trends assumption for the difference-in-difference design.

**Trends in food access and resource constraints and Program participation**



There is another indication that these results are a **violation of the parallel trends assumption**<sup>2</sup>. It might be easier to “move the needle” on hunger, when baseline hunger levels are high, as compared to lower hunger levels. We do know that One Acre Fund farmers were generally more wealthy and less hungry than control farmers. Although the difference-in-difference method eliminates such baseline imbalances in wealth and hunger completely, it does not eliminate the fact that **farmers might behave differently based on baseline characteristics**. To test this, we check for the impact on the same FANTA scores and the related self-reported indicators based on the baseline poverty levels. We divided all farmers in the sample based on their poverty score calculated using in Poverty Probability Index (PPI score). All farmers who were found to have more than a 30% probability of living under \$2 a day were classified as poorer, and anyone under 30% chance was classified as wealthier. The classification did not depend on program participation. One Acre Fund and control farmers were spread across both poverty groups. After running the analysis, we **find that those in the poorer group experienced a much higher improvement in hunger than the wealthier group across the four years of the study**. Looking at the graph below, it is clear that, barring the drought year, both groups experienced a decrease in hunger (calculated through the FANTA score). However, the slope is much more steep for the poorer group because **they are the ones facing graver hunger and there is more room for improvement**. Similarly, they were worse affected by the drought given they were more vulnerable.

**Trends in FANTA score based on Baseline Poverty Score**



An interesting and consistent finding across all three years of the study has been related to **changes in income choices due to program participation**. Farmers continue to be seen as “**leaning away**” from **non-agricultural businesses** as compared to control farmers. This is represented by a decrease in business activity and business profits for One Acre Fund farmers. Our qualitative analysis in Year 2 had revealed that this simply **reflects farmer preferences**. An increase in agricultural profit does not necessarily provide an impetus to non-agricultural businesses. Our quantitative analysis revealed that most One Acre Fund farmers that participated in the discussions reported a preference to invest agricultural profit back into farming (by increasing acreage, inputs, etc.) rather than into non-agricultural businesses.

<sup>2</sup> The parallel trends assumption is one of the basic tenets of carrying out a DID estimation. It assumes that any external shock affects both groups in the same direction and similar magnitude.

*“I settled in farming and began with half an acre. Later, I planted an acre of maize and managed to harvest 13 bags of maize, which helped in paying my children’s school fees. The remainder was reserved for domestic consumption. This has greatly encouraged me to stick to farming due to the huge profits gained. I also plant and sell the Sukuma Wiki being supplied by One Acre Fund and the income earned is used to cater for my household needs. ” (Female-only focus group, One Acre Fund Clients, Busire, Kenya)*

*“ If I get more harvest, I can sell some at a good price and use the money to buy something that will be productive like chicken. I will put that money in business and make it grow. I will put back in farming by leasing some land and preparing for the next season. ” (Female-only focus group, One Acre Fund Clients, Eluche, Kenya)*

One Acre Fund farmers also reported a decrease in their self-reported income over the two weeks preceding the time of the survey (before harvest and during the hunger season). Note that income for farmers is highly variable throughout the season. Therefore, this **two-week decline is not necessarily reflective of their total income in the year** (which would also depend on maize profit and other income sources). The most substantial drivers behind the decrease in income was a decline in business profits and wages. Our qualitative analysis uncovered that farmers do not view working for wages as a preferred method for earning money due to the hard physical labor involved and relatively little monetary returns.

*“Working as a casual laborer is a very hard job. You can be given a very wide place to dig, but the payments are just peanuts. I hate that job.”(Female-only FG, One Acre Fund Clients, Eluche, Kenya)*

In other exploratory areas, **One Acre Fund farmers reported much higher happiness and less stress**, attributed to the program. We did not detect any impact in other areas such as financial literacy, women’s economic empowerment, health outcomes, or child nutrition. We find certain remnants of older One Acre Fund policy, recommending monocropping, in these results. One Acre Fund farmers in the study area were more likely to prefer planting one crop over multiple crops. Despite these attitudes, we measured a positive impact on crop diversity in other internal studies. For example, in the [2017 Resilience study](#), we found that clients in Kenya (where dependence on maize is relatively high) started to have more diversified crops after participating in the program for over a year, compared to newly enrolled clients. There has been a recent organization-wide push towards intercropping and crop diversity and these should reflect in other areas of the program going forward.

**Learnings and Programmatic Changes:** Overall, this study has helped us gain invaluable insights on our program impact as well as providing a deeper understanding of farmers and their priorities. The study has shown that decreased hunger does not immediately lead to better nutrition outcomes and dietary diversity. We have now ramped up our investments in a range of health and lifestyle outcomes such as better nutrition, behaviour change training, and innovation in products such as poultry, health insurance, among other add-ons that hope to improve household nutrition and growth. We have also started ambitious programs in Kenya to directly tackle nutrition outcomes for children under five and pregnant women.

The 2016 drought was a stark reminder of just how vulnerable smallholder farmers are to income and agricultural shocks. We have galvanized our focus on not just building farmer income but also their resilience. To tackle this, One Acre Fund’s leadership is making concerted efforts to improve the crop insurance that we provide clients so they have meaningful buffers to various agricultural shocks. As an

organization, we are also making significant investments, enabling farmers to build agroforestry assets and improve crop diversity. These areas can also provide useful income diversity during difficult times. Over the next few months, we will also be looking into the results of the study in greater detail to uncover other areas of programmatic improvements in addition to changes already in motion through earlier headline findings around nutrition, resilience and asset building.

SUMMARY FINDINGS FROM THE YEAR 3 STUDY IN KENYA			
KEY	Moderate to strong evidence of impact	Minimal to weak evidence of impact in the study	Unexpected findings
<p><i>Note on Presentation: We have reported differences that are statistically significant at <math>p &lt; .05</math> are highlighted. This means there is a less than 5% chance these differences would be found by chance.</i></p>			
<b>A. Areas where we expected to see Impact</b>			
Agriculture and Maize Profit	<p><b>Harvest size:</b> Clients self-reported a high increase in maize yield by 405 kg more than control farmers. Controlling for land size, this translated into 245 kg per acre more than control farmers. Physical measurement of harvests for One Acre Fund clients revealed even greater results - these farmers harvested 371.8 kg per acre more than control farmers.</p>		
	<p><b>Land Size Cultivated:</b> One Acre Fund farmers increased their total area cultivated for agriculture (top four crops) by 0.41 acres compared to control over the three years under study. This provides further evidence that program farmers are “leaning in” to agriculture.</p>		
Hunger	<p><b>Maize Surplus during Hunger Season:</b> As a result of the increase in maize harvest due to program participation, One Acre Fund farmers were 22.8% pts. more likely to have maize remaining from their harvest during the hunger season. Relatedly, there is weak evidence (<math>p &lt; 0.1</math>) that One Acre Fund farmers had 16.5 kg of total maize more than controls remaining during that period.</p>		
	<p><b>Dietary Diversity:</b> No evidence of impact in this study.</p>		
	<p><b>Subjective Hunger indicators like FANTA Score:</b> Nullified by parallel trends violation.</p>		
Education	<p><b>School Attendance:</b> No evidence for impact, possibly because baseline levels were already very high.</p>		
	<p><b>Homework hours:</b> Strong evidence that children of clients studied 0.3 hours more, on average, compared to children in control households.</p>		
	<p><b>School fees:</b> Program impact on an increase in school fees for children under 6 and those in secondary school.</p>		
Assets	<p><b>Total Physical Assets:</b> Weak (<math>p &lt; 0.1</math>) evidence of an increase in total physical assets. However, looking at individual assets, this is largely driven by an increase in ownership of solar lights and trees. Impact on individual physical assets isn’t surprising as One Acre Fund provides solar lights and trees as part of program offerings and these are making a marked difference in their asset base.</p>		
	<p><b>Total Livestock Assets:</b> Strong evidence that livestock assets increased in value by \$96.8 for treatment farmers. This is largely an increase in bovine ownership for One Acre Fund farmers.</p>		
	<p><b>Total Financial Assets:</b> No evidence of impact in this study.</p>		
Consumption	<p><b>Consumption during hunger season:</b> No impact when surveyed during the hunger season. However, because this is 8 months after harvest, we hypothesized that any bump in consumption from improved harvest had dissipated.</p>		
	<p><b>Consumption after harvest season:</b> When we added a short module on consumption after the harvest season, we begin to pick up on impact in consumption of food. One Acre Fund households consumed food worth \$1.6 more than controls in the past two days. We believe to be a more modest representation of our impact because One Acre Fund farmers might behave differently with the seasonal fluctuations than control farmers.</p>		

Income	<b>Maize Income:</b> We estimate that One Acre Fund farmers in study areas had an increase in their maize profit by \$99.3 compared to control farmers. When we look at percentage improvements for farmers, this represents a 39% increase in maize profit.
	<b>Non-Agricultural Businesses:</b> There was a decrease in the share of clients reporting to have more than half of their income from non- agricultural businesses by 37.2 percentage points. There was also a decrease in the total businesses run by One Acre Fund farmers by 0.17. Our qualitative work showed that this is because farmers usually prefer to invest their farming profits back into farming as it becomes more profitable.
	<b>Income in the 2 weeks preceding the survey (hunger season):</b> One Acre Fund farmers reported a decrease in income of \$10 as compared to control farmers during the past 2 weeks at the time of the survey in the hunger season. This was mainly driven by a decrease in business profit for One Acre Fund farmers because of their reduced investments in that area. There is also some evidence on a decrease in wage income (which we have detected in all years of the study). The qualitative inquiry showed that wage labor during the hunger season was a strategy of desperation which One Acre Fund clients were less likely to employ.
Health	<b>Sickness and ability to seek treatment:</b> No evidence for impact in this study.
<b>B. Truly Exploratory Areas</b>	
Well Being	<b>Stress:</b> One Acre Fund farmers in Kenya reported much less stress of 0.8 points (as calculated on the total index score). This is mainly driven by farmers’ increased confidence in handling personal problems and feeling that things were going their way and ability to handle personal problems.
	<b>Happiness/Satisfaction:</b> One Acre Fund farmers also reported higher satisfaction and happiness with their lives as a whole and when compared to the previous year.
Financial Literacy	<b>Total Budget and Planning Score:</b> No evidence for impact in this study
	<b>Crop Diversity Attitudes:</b> Surprisingly, One Acre Fund farmers were more likely to prefer planting single than multiple crops than control farmers by 30 percentage points. These crop diversity attitudes might be a legacy of previous recommendations to farmers to mono-crop their maize. However, there is now a push towards intercropping and increasing cop diversity for One Acre Fund farmers in Kenya and, despite these attitudes, we have actually measured a positive program impact on crop diversity in Kenya in the <a href="#">2017 Resilience study</a> .
Women’s Econ Empowerment	<b>Household Decision Making:</b> No evidence for Impact in this study
Child Nutrition	<b>Child Anthropometric Measurements:</b> No evidence for impact in this study.

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## REPORT

### Purpose of Study

The ultimate goal of One Acre Fund is to reduce poverty and improve the quality of life for the farming families we serve<sup>3</sup>. Over the years, we have built a substantial body of evidence showing that participation in our program contributes to an increase in both yield and farm profit. Back in 2015, the organization had little information on the ways in which the program was impacting several aspects of farmers' lives and how impact may vary with seasonal fluctuations and other external shocks.

The central purpose of our Quality of Life Study is to understand and assess our impact on farmers' lives more holistically. This study was focused on the One Acre Fund programs in Kenya and Rwanda. We intended to investigate secondary program impacts, such as spending on education, health and hunger outcomes and purchase of productive assets, through this longitudinal study in Kenya and Rwanda.

### Methodology

#### *Geographic Coverage and Selection*

Our goals for selecting a study design were to identify a control group which (1) looks similar to our farmers in terms of difficult-to-observe characteristics like motivation and risk (i.e. to avoid the "selection bias" problem when choosing a control group which did not self-select into the program), and (2) to be operating in a similar environment to control farmers. This is important for tracking groups over time. For example, if a non-governmental organization providing nutrient supplements moved into one area, it would be more difficult to attribute any changes in health outcomes solely to the One Acre Fund program.

We have selected the control farmers over the program boundary. This helps us mitigate spillover while ensuring a similar agro-ecological and social service environment. In Kenya, the study was conducted in the district of Busia and in the district of Ngororero in Rwanda. The sites were chosen as they fulfilled a set of predetermined criteria such as being relatively new program sites, representative in terms of agro-ecological conditions of our typical program areas, not being a trial site and having a cluster of sites around the area without any program intervention to serve as controls which were separated by an arbitrary border. For complete details on how the sites were chosen, please refer to Annex B.

#### *Study Design*

The report presents the results from the fourth round of data collection in Kenya (baseline, year 1, year 2 and year 3). We have pursued a **difference-in-differences approach** to study changes in the outcomes of interest. The control farmers were selected from just across the program boundary with very similar characteristics to the One Acre Fund farmers. At the baseline, we found some differences between One Acre Fund and control farmers. Compared to control farmers, One Acre Fund farmers were more educated, more likely to be married, slightly older, and tended to have larger families amongst other differences. To control for these differences, we undertook **propensity score matching** to ensure our control group was adequately comparable to the treatment group.<sup>4</sup>

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<sup>3</sup> For a detailed description of the program in Kenya, please refer to Appendix A.

<sup>4</sup> For a complete overview of our matching strategy and approach, please refer to Annex D. Please refer to Annex C for complete list of possible risks and steps taken to mitigate the risks to the extent possible.

### **Supplemental Survey During Non-Hunger Season**

From 2015 to 2018, data collection for this study was undertaken once each year during the hunger season. The reason for this was to understand differences when the situation was more dire for farmers in the area. One drawback to this timing was that we were not able to glean effects when harvest impact was more recent for some behaviours, such as consumption and income, which are highly seasonal in nature.

To address this, we fielded a mid-cycle supplemental survey, in November 2018, a few months after the harvest season. The aim of the supplemental survey was to give us insights into certain farmer behaviors that would have otherwise been overlooked during hunger season data collection. We followed the same cohort of farmers as the main QoL study and used the same methods outlined in study design above for analysis.

### **Note on Presentation of Analysis**

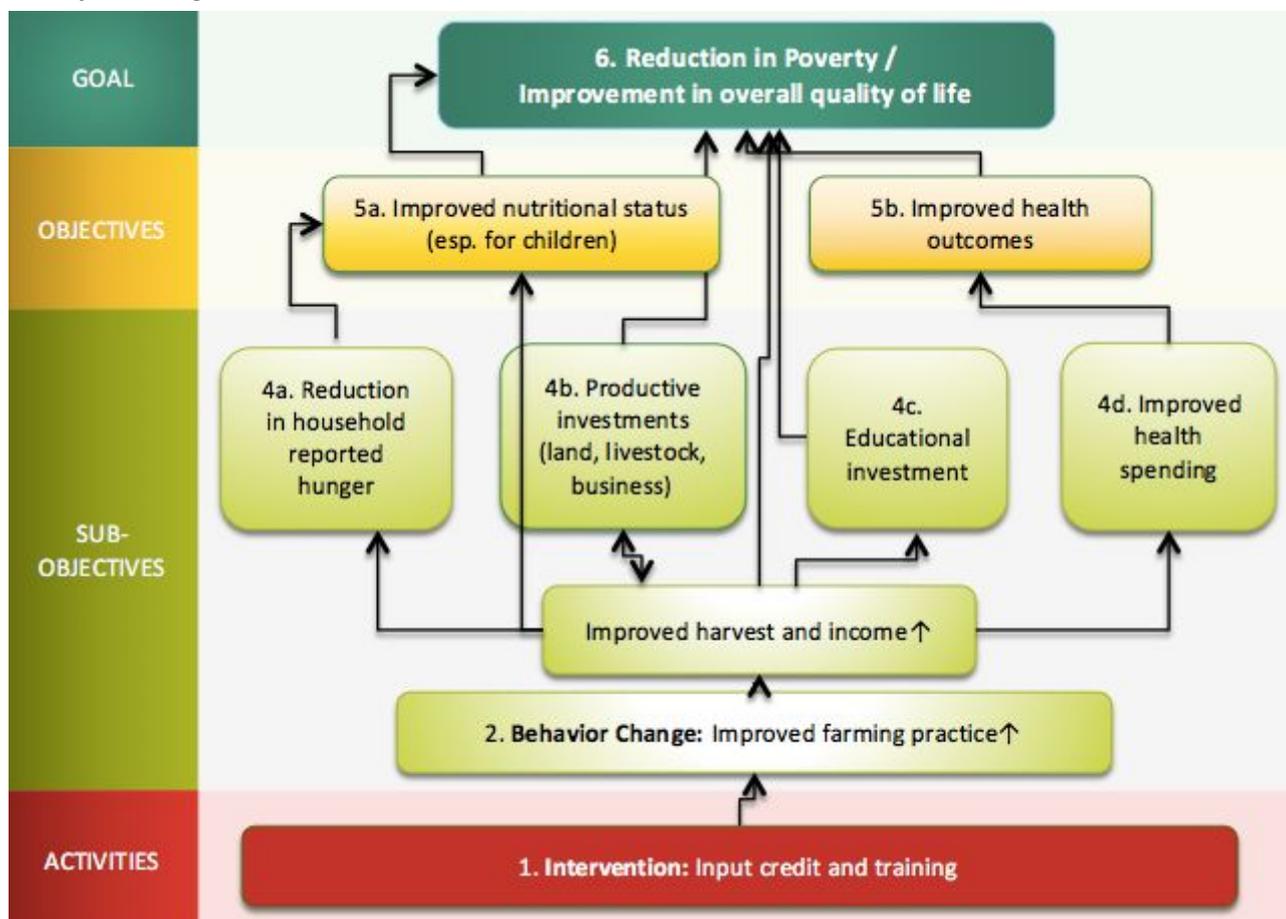
As we are reporting results from several hypotheses in this report, we will often refer to the difference-in-difference results (i.e. the change noticed in One Acre Fund farmers in comparison to control farmers over the period of time from the baseline to the follow up round) interchangeably with “impact”. We have reported differences that are statistically significant at  $p < .05$  which are highlighted. This means there is a less than 5% chance these differences could be found by chance.

### **Context for Study**

As per our pre-established analysis plan, we hypothesized that we will have some impact on agricultural productivity, education expenditures, and hunger based on our prior data collection efforts and analyses. We were also interested in understanding how that impact would translate into better dietary diversity, asset accumulation, financial education, gender dynamics and nutrition. Below is a simplified visual of our ‘theory of change’, illustrating the path from what we do ( program components) to achieving long-term impact goals.

In the first year of the study, when there were no major weather shocks, we noted a significant increase in agricultural productivity and decrease in hunger relative to controls in both countries (lower impact seen in Rwanda likely due to poor bean seed germination in the study area). This translated into an increase in livestock asset accumulation by Kenyan farmers (none in Rwanda probably due to the lower harvest). Surprisingly, we did not see much increase in education outcomes for children in One Acre Fund households. In Kenya, this was likely partly due to already high baseline educational attendance. Although there was no change in consumption patterns in Kenya; we saw an increase in the total consumption in the past two weeks of the survey as well as one year as compared to control farmers. Perhaps due to increased agricultural productivity, One Acre Fund farmers in Kenya and Rwanda also reported relying less on non-agricultural income streams over the study period (as compared to control farmers). A higher share of children in One Acre Fund households were reported to be consuming more nutritious food items such as milk (in Kenya) and fish and meat (in Rwanda).

## Theory of Change



Our ability to programmatically achieve, and rigorously measure, program impacts depend on a variety of external factors. However, in 2016 (the second year of the study), we had unique challenges that affected both our program’s ability to *generate* impact as well as this study’s ability to *detect* impact, across both countries. They are listed below:

1. **The 2016 Drought (Kenya):** In 2016, the short and long rains in Kenya (especially in Arid and Semi-Arid Lands (ASAL)) was below average. This resulted in a severe drought which also had an adverse effect on crop yields during this season. Busia, the site for this study, was particularly badly hit by drought, suffering from a large decrease in average maize yield per acre. In the event of drought, the program’s ability to influence farmer’s lives is limited when compared to non-drought years where impact is relatively higher. Using better inputs and planting practices are simply not enough to fully insulate significant external agricultural shocks. In such a year, even though One Acre Fund clients in Busia saw better harvest outcomes than non-clients (and also their own baseline measures), it was still not enough to cushion them from the drought completely and they were worse-off than in other years when they were a part of the program and rainfall patterns were more consistent.

2. **Violation of Parallel Trends Assumption (Rwanda)**<sup>5</sup>: Our qualitative analysis (interviews with village chiefs) in Rwanda study areas revealed that treatment and control sites faced dissimilar external shocks between 2016 and 2017. Treatment sites were more likely to face drought and pests than control sites in 2017. On the other hand, control sites had more market access and public health programs from other NGOs than treatment sites. Essentially, one of the basic tenets of carrying out a difference-in-difference evaluation, the parallel trends assumption (that any external shock affects both groups in the same direction and similar magnitude) may have been violated.
3. **Program Attrition (Rwanda)**: In the study design, we anticipated the likelihood of program attrition (both from the study as well as the program) over the 4-year study duration. However, in Rwanda, program attrition has been relatively larger than we had forecast. Traditionally, a large proportion of **A** season clients did not rejoin for the **B** season when beans are the main crop to which farmers do not apply fertilizer. As the baseline was carried out in **A** season and the year 2 study was carried out in **B** season, some attrition was expected. Around 41% of One Acre Fund farmers did not rejoin the program in 2017 (compared to Kenya's attrition of 29%).
4. **Government Permissions (Rwanda)**: In Year 2, due to government restrictions, we were not able to collect measurements for children in our sample in Rwanda and we were likely not get such permissions for coming years as well. In addition, we also faced difficulties in obtaining permits to collect non-anthropometric data.

Considering the violation of the parallel trends, difficulty in obtaining government permissions to collect certain types of data, and the high level of attrition we believed that the costs of the study no longer outweighed the benefits and discontinued the study in Rwanda after Year 2.

As a result of the above, we observed little increase in maize yield per acre for One Acre Fund farmers in Kenya and none in Rwanda. These results were in sharp contrast to the findings in the first year of the study where we saw much higher increases in agricultural productivity. The first and foremost link in the theory of change is the impact on agricultural practices and yields for One Acre Fund farmers. When we **find a weak impact on the first link itself, it is very unlikely that we are able to have much impact on other quality of life indicators** that occur as a result of higher harvests. Due to the unprecedented poor agricultural year and other study design issues, we did not find an increase in many of the secondary impact areas. However, we did find evidence that program participation may have helped cushion the blow of a difficult harvest year for treatment farmers in Kenya. We also noted evidence that One Acre Fund farmers used the livestock asset gains made in a good agricultural year to be sold for consumption, smoothing during the time of a drought shock.

## Year 3 Results

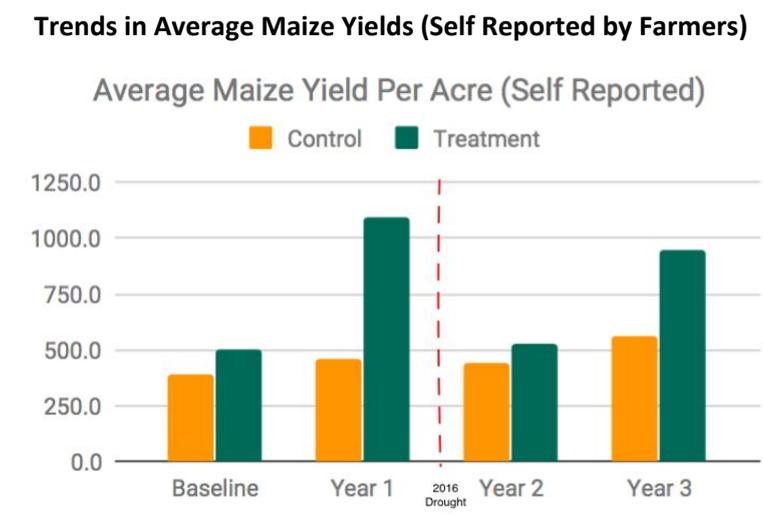
### Agriculture

**Maize Yield Impact:** In the third, and final, year of the study, we see a strong increase in maize yield for One Acre Fund farmers in Kenya. The self-reported results show that One Acre Fund farmers had an increase in maize yield by 405 kg per acre and a total maize yield impact of 278 kg. These results are verified (and actually exceeded) in the physical harvest measurements conducted by the One Acre Fund team in the area

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<sup>5</sup> The parallel trends assumption is one of the basic tenets of carrying out a DID estimation. It assumes that any external shock affects both groups in the same direction and similar magnitude.

for a subset of participants in the study. In 2017, 258 farmers participated in the physical harvest measurement of which, 92 were One Acre Fund farmers and 166 were control farmers. We found that, on average, One Acre Fund farmers harvested 371.8 kg per acre more than control farmers. The average yield for controls was 1015 kg per acre, whereas One Acre Fund farmers in the study had an average maize yield of 1386.7 kg per acre.



Although these results are highly significant ( $p > 0.01$ ), it is worth noting that the program impact on maize yield in the study area is comparatively lower than in the rest of the One Acre Fund program. In the same year, the average program impact was 543 kg/acre. Over the three years of the study, we have consistently seen lower than average performance in the study area than in the rest of the program. The first and foremost link in the theory of change is the impact on agricultural practices and yields for One Acre Fund farmers. It is likely that the results on the quality of life outcomes are dampened as well as compared to the rest of the program due to the lower than average harvest impacts.

**Total Area Cultivated:** One Acre Fund farmers also increased the total area cultivated for agriculture (top four crops) by 0.41 acres compared to control over the three years of the study. We note that the total area cultivated increased for every additional year of program participation, indicating that there were incremental benefits of each year of program participation towards the widening of clients’ agriculture base.

Agricultural Outcomes - Difference in Change Over Time for One Acre Fund vs Control Farmers			
Outcomes of Interest			
Year compared to the baseline	2016	2017	2018
Total Maize Yield per Farmer (kg)	248.3***	-31.28	277.9***
Maize Yield Per Acre (kg per acre)	402.5***	86.99***	405.3***
Total Area Cultivated (4 main crops)	0.304***	0.368***	0.413***
% who evaluated good harvest (Maize)	44%***	-2.60%	18.4%***
Difference in Physically Measured Harvest (kg per acre)	638***	161.44**	371.8***
*** $p < 0.01$ , ** $p < 0.05$ , * $p < 0.1$			

**Impact (profit comparison) measurement:** Traditionally, One Acre Fund estimated program impact by comparing One Acre Fund farmers' profit from harvests with those of non-One Acre Fund farmers'. In this section, we try to arrive at a rough estimate of the increase in annual farm profit for the farmers in the study area. We typically measure all facets of agriculture such as the farm crop-mix, land size, agricultural input costs, market price, and consideration of any program impact on land size. The quality of life study's primary focus was to understand the program's secondary impact and, therefore, many components of the traditional impact figure were not included in our survey questionnaires. The impact number that we suggest here is, therefore, based on several assumptions from 2017 annual program impact components where we collected extensive data points. We then plug the measured harvest results into the program impact calculations in order to arrive at the impact figure below. Our assumption is that the study region's agricultural environment is similar to that of the surrounding region.

**Results:** In Kenya, we estimate that the annual program impact from maize in the program area was on average \$117.8 more than control farmers, which is an improvement in maize profit by 28%. In the QoL area, after plugging in the harvest results in the same model, we find an increase in maize profit by \$99.3. Busia, the site of the study, has historically lower baseline levels of maize income than the rest of the program. When we look at percentage improvements for farmers, this represents a 39% increase in maize profit. This shows that, although the impact in the study area as a whole is lesser than the program average, it represents a higher value-add for farmers than the program average.

Profit Impact	Kenya	
	2016	2017
Year		
\$ impact program-wide	\$66.30	\$117.8
Estimated \$ impact in QoL study area	\$16.49	\$99.3

## Hunger

**Measurement:** To measure hunger, we asked several questions to capture outcomes related to experiencing hunger as well as the food intake and nutrition of the household. We have used USAID's Food and Nutrition Technical Assistance (FANTA) Score to create an indicator to measure hunger. The FANTA Score is a weighted average concerning the scarcity of food, the prevalence of sleeping hungry and complete days spent in hunger. Farmers were also asked to describe the intensity of the hunger season they faced based on the frequency in which they went hungry. To measure the dietary diversity of the household, we asked farmers to report all food groups listed that they had consumed in the two days preceding the survey. The final dietary diversity score was then compiled by aggregating all food groups consumed, which may potentially range from 0 to 11.

**Maize Remaining during Hunger Season:** As a result of the increase in maize harvest due to program participation, One Acre Fund farmers were 22.8% pts. more likely to have maize remaining from their harvest during the hunger season. Relatedly, there is weak evidence ( $p < 0.1$ ) that One Acre Fund farmers had 16.5 kg of total maize more than controls remaining during that period.

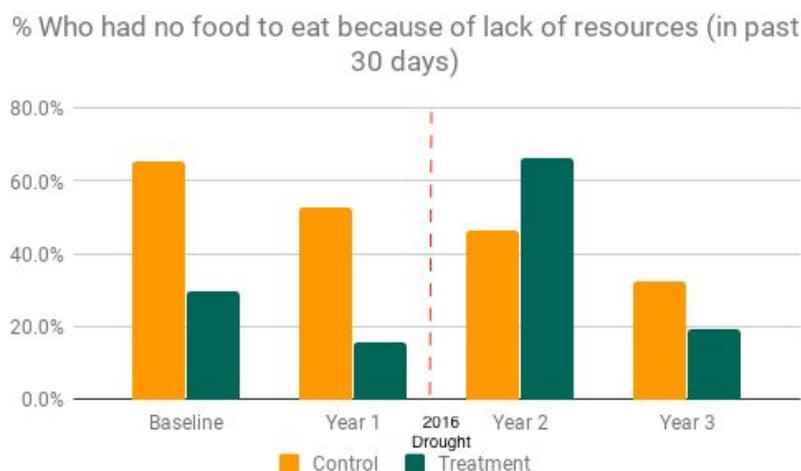
**Dietary Diversity:** We find no statistically significant impact on dietary diversity due to program participation. In the first year of the study, we found an impact of increased diversity by 0.31 points (out of

11). Although the direction of the results stays on the positive side, the impact on dietary diversity is no longer significant in Year 2 or Year 3 of the study.

**FANTA Score:** Surprisingly, we find evidence of negative impact on self-reported hunger (measured through the FANTA score) for One Acre Fund farmers compared to controls. At the baseline, hunger levels for control farmers were already much higher than One Acre Fund farmers and, after three years, controls still reported higher hunger than One Acre Fund farmers. Over the three year period, **both One Acre Fund farmers and control farmers experienced a decrease in hunger. However, control farmers still had a much larger decrease in hunger than One Acre Fund farmers.**

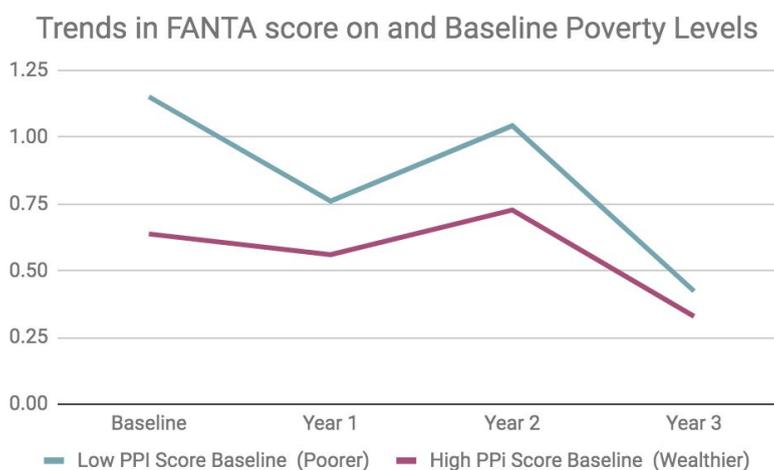
There is a rather peculiar trend in hunger for control farmers in relation to the agricultural year. Looking at the graph below, it is clear that One Acre Fund client reported hunger is in line with the harvests that season. In good harvest years, we see a dramatic decrease in hunger (like Year 1 and Year 3) and a spike in hunger levels during drought years (Year 2). However, we do not see the same trends in control farmers, which seems to suggest that there is an external threat to the validity of the parallel trends assumption for the difference-in-difference design.

### Trends in Food Access and Resource Constraints and One Acre Fund Participation



There is another result which indicates a **violation of the parallel trends assumption**. It might be easier to “move the needle” on hunger, when baseline hunger levels are high, as compared to lower levels. We do know that One Acre Fund farmers were generally more wealthy than control farmers. Although the difference in difference eliminates baseline imbalance completely, it does not eliminate the fact that **farmers might behave differently based on their baseline characteristics**. To test this, we checked for the impact on the same FANTA scores and the related self-reported indicators based on the baseline poverty levels. We divided all farmers in the sample based on their poverty score calculated using in Poverty Probability Index (PPI score). All farmers who were found to have more than a 30% probability of living under \$2 a day were classified as poorer, and anyone under 30% chance was classified as wealthier. The classification did not depend on program participation. One Acre Fund and control farmers were spread across these poverty group. After running the analysis, we **also find that those in the poorer group experienced a much higher improvement in hunger than the wealthier group in the four years of the study**. Looking at the graph below, barring the drought year, it is clear that both groups experienced a decrease in hunger (calculated through FANTA score). However, the slope is much more steep for the poorer group because **they are the ones facing much graver hunger and there is more room for improvement**.

### Trends in FANTA score based on Baseline Poverty Score



For detailed results on the hunger outcomes, please refer to **Annex E**.

### Assets

**Background:** The survey asked farmers to report on three categories of assets: (1) physical without house and land (such as furniture, radios etc.), (2) financial (value of money kept in savings, merry-go-round, and cash), and (3) livestock. Farmers were also asked to value each asset at its current value (the price they would be able to sell each item for at present prices ). We found the self-reported values estimated to be highly unreliable. Instead, we assigned a typical value of each asset usually found in the area of our study and multiplied the reported quantity by the average value of the asset.

**Results:** In Year 3, we see a significant impact on most asset indicators. One Acre Fund farmers increased their overall, physical and livestock assets value compared to controls after three years of program participation. There has been no statistically significant impact on financial assets as reported by the farmers.

Looking at individual assets, this increase is largely driven by an increase in ownership of solar lights, trees, and cows. Impact on solar lights and trees isn't surprising as these assets are part of program offerings and are helping widen the asset base of clients. In our quantitative inquiry in 2016, farmers had reported prioritizing investments in livestock, and they seem to be doing just that after participating in the One Acre Fund program.

Asset - Difference in Change Over Time for One Acre Fund vs Control Farmers	
Year compared to the baseline	2018 Annual Study)
<b>Overall Asset Value</b>	
Total Assets Value (without house and land value) in USD	<b>635.7 **</b>
Total Physical Assets Value (without house value) in USD	<b>538.9 *</b>
Total Financial Assets Value in USD	18.38
Total Livestock Assets Value in USD	<b>96.8 **</b>
*** p<0.01, ** p<0.05, * p<0.1	

## Income

Although we measure an increase in maize profit as a result of program participation, we are also interested in understanding the increase in total income and income choices as a result of program participation. There are several constraints in how representative the information we get is on income because the survey from this study is only conducted once a year. Income for farmers is highly variable throughout the season. As a result, we are only able to see a snapshot of a farmer's total income at the time the survey is being conducted.

**Non-Agricultural Businesses:** An interesting and consistent finding in all three years of the study has been related to changes in *income choices* due to program participation. One Acre Fund farmers continue to be seen as “leaning away” from non-agricultural businesses as compared to control farmers. As a result of program impact, the share of One Acre Fund farmers reporting to have more than half of their income from non-agricultural businesses decreased by 36.9% points over the period of study compared to controls. There was also a decrease in the total non-agricultural businesses due to program participation by 0.17. The decrease in businesses is driven less by any changes in the number of control businesses (who actually also had a slight decrease) but rather by a decrease in the total businesses owned by One Acre Fund farmers.

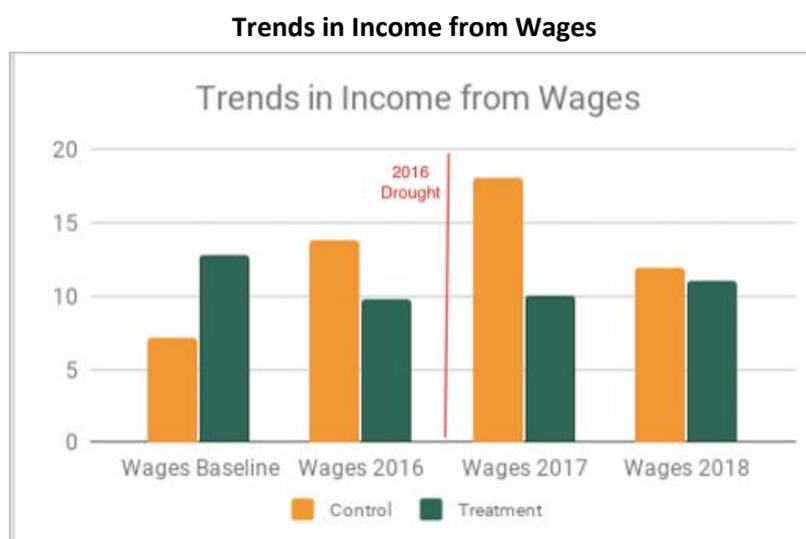
The qualitative analysis in both countries shows us that these findings simply reflect farmer preferences. An increase in agricultural profit does not necessarily provide an impetus to non-agricultural businesses and the relationship is not as linear as we may have believed at the beginning of the study. Most participants reported preferring reinvesting agricultural profit back into farming (by increasing acreage, inputs etc.) rather than into non-agricultural businesses. For those who did mention they would also invest agricultural profit into other businesses, it was almost always related to investing half in farming and half in these businesses. Rwandan farmers also preferred to reinvest agricultural profit back into agriculture rather businesses in other sectors due to the higher risk perceived. They mentioned feeling more comfortable reinvesting in agriculture because they are already familiar with it.

*“I settled in farming and I began with half an acre. I later on planted an acre of maize and managed to harvest 13 bags of maize, which helped in paying my children’s school fees as the remainder, was reserved for domestic consumption. This has greatly encouraged me to stick to farming due to the huge profits gained. I also plant and sell the Sukuma Wiki being supplied by One Acre Fund and the income earned is used to cater for my domestic needs.” (Female-only focus group, One Acre Fund Clients, Busire, Kenya)*

*“ If I get more harvest, I can sell some at a good price and use the money to buy something that will be productive like chicken. I will put that money in business and make it grow. I will put back in farming by leasing some land and preparing for the next season. ” (Female-only focus group, One Acre Fund Clients, Eluche, Kenya)*

**Maize Annual Income:** As mentioned in the agriculture section, we estimate that One Acre Fund farmers in study areas had an increase in maize profit by \$99.3 compared to control farmers. When we look at percentage improvements for farmers, this represents a 39% increase in maize profit.

**Income in Two Weeks Preceding the Survey (During Hunger Season):** One Acre Fund farmers reported a decrease in income of \$10 as compared to control farmers in the 2 weeks preceding the survey during the hunger season. This was mainly driven by a decrease in business profit for One Acre Fund farmers because of reduced investments in that area. These are in line with our findings in the section above on clients leaning more into agriculture after program participation, and away from non-agricultural businesses.



There is also evidence of a decrease in wage income, which we have found consistently over the three years of the study. The qualitative inquiry showed that wage labor is more of a strategy of desperation which One Acre Fund clients were less apt to employ. We asked farmers in the study areas in Kenya to provide their thoughts on working for daily wages. There was strong consensus in the focus group meetings that working for casual wages was a non-preferred method for earning money. The participants reported that such work involves a lot of physical labor with comparatively smaller remuneration and there was uncertainty tied with this because there was a possibility that they might not get paid even after completing the work.

*“I think if you get used to do that kind of job (daily wages), you can never develop because you cannot get time to do your own thing. You will be always on the road looking for the casual labor job, which has less payment with a lot of work.” (Female-only FG, One Acre Fund Clients, Eluche, Kenya)*

*“Working as a casual laborer is a very hard job. You can be given a very wide place to dig, but the payments are just peanuts. I hate that job.”(Female-only FG, One Acre Fund Clients, Eluche, Kenya)*

Year compared to the baseline	2016	2017	2018
Total Income in past two weeks (USD)	-6.9***	-13.62***	-10.0 ***
Total income in the past 2 weeks (excluding remittances - USD)	-5.1***	-11.54***	-8.7 ***
<b>Non-Agricultural business</b>			
% of household who have any non-ag business	-4.6%	-13.1%***	-10.6% *
% who receive more than half of income from activities other than farming	-30.4%**	-28.3%***	-36.9%
Average business profit per typical farmer in the past month	-5.4*	-5.58	-6.2
Average business profit in the past month (only those who had a business)	-6.8		-18.3
Total # of businesses per household	0.05	-0.17***	-0.17 **
Ave # of businesses created in the past year per hh	-0.06***	-0.03	-0.03
% of hh who created a non-ag business in the past year	-5.7%***	-2.25%	-3.0%
<b>Details of self-reported income (past 2 weeks)</b>			
Wages Income	-2.6*	-5.8***	-4.2 *
Selling Eggs Income	0.04*	-0.06	0.1
Selling Milk Income	-0.1	0.03	0.1
Selling Livestock Income	-0.2	-0.21	0.9
Selling Grains Income	-0.6	-2.6***	-0.6
Selling Vegetables Income	0.1	0.13	-0.3
Remittances Income	-1.8**	-2.1*	-1.3
Business Profit Income	-1.7*	-3***	-4.7 **

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

## Consumption

Over the three years of study, we did not detect any impact on consumption in Kenya when we collected the data during the hunger season. We hypothesised that this might have to do with the timing of the survey which was a full eight months after harvest and its associated impacts. The results from the new short module added after harvest season showed that One Acre Fund actually had an impact on the **consumption of food in the two days prior to the survey**. We believe this to be a more modest representation of our impact during the harvest period because One Acre Fund farmers might behave differently with the seasonal fluctuations than control farmers.

Consumption - Difference in Change Over Time for One Acre Fund vs Control Farmers				
Outcomes of Interest	2016	2017	2018	2018 (Mid Cycle Study)
Year compared to the baseline				
<b>Overall Consumption Value</b>				
Value of large purchases in the last year (in USD)	13.3	-1.3	10.1	-64.6

Value of all purchases in last 2 weeks (in USD)	0.2	0.2	0.6	1.2
Value of food consumed in last 2 days (in USD)	-0.2	0.2	0.4	<b>1.6***</b>
*** p<0.01, ** p<0.05, * p<0.1				

## Child Education

Overall, we find that the program did not contribute any gains to school attendance for children (possibly due to already high baseline levels), but did have an impact on the quality of education outcomes such as homework hours and investment in school fees.

**School Attendance:** We find no significant impact on school attendance. However, baseline school attendance rates were already high at over 90% for both, treatment and control so the differences are minute here.

**Homework:** We find consistently strong evidence that children of clients studied more on average as a result of the program than children in control households. In Year 2, the impact on average hours of homework was 0.14 hours, and in Year 3 of the study, this increased to 0.23 hours. This might also be a result of an increase in ownership of solar lights for One Acre Fund farmers through the program which allows the children to study once the natural light is no longer available.

**School Costs:** Following the trend from Year 2, we also observed an impact on the school fees paid for children in One Acre Fund households in Year 3. There was an increase in the average school costs for One Acre Fund children under 6 by \$10.7 and children in secondary school by \$49.2.

Education Outcomes - Difference in Change Over Time for One Acre Fund vs Control Farmers			
Outcomes of Interest			
Year compared to the baseline	2016	2017	2018
<b>School Attendance</b>			
% of children attending school	-3.2%*	<b>-4.8%***</b>	-4.6%
% of children attending private school	1.7%	-1.8%	0.5%
% of school-going children who are girls	6.1%**	3.4%	2.9%
% of those between 5 and 18 who are attending school	-1.4%	<b>-3.1%***</b>	-0.4%
% of those over 13 who are attending school	-3.4%	-3.80%	-7.5%
% of those over 13 who are attending secondary school	-1.8%	5.8%	-7.5%
% of school-going children over 13 who are girls	1.4%	7%	10.0%
% of children 3- 6 attending school	-3.4%	2.04%	
<b>Homework</b>			
Ave hours of homework last school night	0.1	<b>0.14**</b>	<b>0.23***</b>
Ave. hours of homework last night if the child is between 5 and 18	0	0	0.17*
<b>School fees paid</b>			
Ave School costs (outliers winsorize at 2*std. dev)	31.7	<b>8.6**</b>	4.2
School fees paid for under 6 children			<b>10.7***</b>
School fees paid for children in secondary school			<b>49.2***</b>

School Days Missed			
% who says days missed for lack of school fees	-2.6%	0.5%	-1.5%
*** p<0.01, ** p<0.05, * p<0.1			

## Other Outcomes

**Health Access and Spending:** We see no statistically significant difference in health outcomes between One Acre Fund and control farmers, and their families, in any year under study.

**Child Nutrition:** To measure child nutrition, we took physical weights, height and middle-upper arm circumference (MUAC) measurements of all children of five years of age and below in the households covered to better understand the nutritional status of children in our sample.

We find no significant impact on any of the indicators of child nutrition being measured. Strangely, in the first year of study in Kenya, we saw a negative impact on malnourishment rates for children in One Acre Fund households. At that time, we had considered this finding anomalous as it was highly unlikely that One Acre Fund could have made any impact on child nutritional status in only one year. However, we did not find corroborating increases in malnutrition for One Acre Fund children using alternative measures such as MUAC, and we had results showing decreased hunger as well as higher dietary diversity for children in One Acre Fund households. The fact that we do not find any such impact in Year 2 or 3 of the study supports the idea that the negative finding on malnourishment in the first year was a statistical anomaly.

**Financial Literacy:** In Year 1, we found that One Acre Fund farmers were more likely to follow a plan on how they spend their money. In the final year of the study, we also find positive but weak significance ( $p < 0.1$ ) to support this finding which might also be a result of the dwindling sample size in Year 3. Impact on following a plan to spend money might be a positive result of the fact that One Acre Fund farmers need to plan wisely to make program repayments on time.

Surprisingly, One Acre Fund farmers were more likely to prefer planting only one crop over multiple crops than control farmers by 30 percentage points. These crop diversity attitudes might be a legacy of previous recommendations to farmers to mono-crop maize. Despite these attitudes, we have actually measured a positive impact on crop diversity in some One Acre Fund countries. For example, in the [2017 Resilience Study](#), we found that clients in Kenya (where dependence on maize is high) started to have a more diversified crop base as a result of the program. However, there is now a push to encourage intercropping and increase crop diversity for all One Acre Fund farmers in Kenya.

**Well-Being:** A steady finding from most years of the study is that One Acre Fund farmers improve their mental well being due to program participation.

After three years, One Acre Fund farmers reported lower stress of 0.8 points (as calculated on the total index score of 16 points). This is mainly driven by farmers' increased confidence in handling personal problems and some evidence that they were feeling that things were going their way. One Acre Fund farmers also reported higher satisfaction and happiness with their lives as a whole and also when compared to the previous year.

**Women Empowerment:** The One Acre Fund program does not explicitly have a gender empowerment program and we do not expect to impact gender norms, as such behaviors can take years to change. However, we were interested in confirming whether the program had any indirect impacts on these complex cultural structures. We do not find any impact on the total empowerment score in Kenya after three years of the program.

Other Outcomes: Difference in Change Over Time for One Acre Fund vs Control Farmers			
Outcomes of Interest	Kenya		
Year compared to the baseline	2016	2017	2018
<b>Financial Literacy</b>			
Total Budget and Planning Score	0.611*	0.48	-0.304
<b>Health</b>			
% of households reporting an illness in last 2 weeks	4.8%	0.9%	9.9%
% of those who sought treatment who saw a doctor or nurse	-5.6%	-1.5%	9.2%
Ave health costs (outliers winsorized at 2*std. dev)	11.1	3.2	3.3
<b>Well Being</b>			
Total Stress Score (higher score=more stress)	-0.8***	-0.8***	-0.9**
<b>Women Empowerment</b>			
Total Women Empowerment Score (0 = woman not a decision-maker in any aspect, 10 = woman is the primary decision-maker in all aspects)	-0.03	-0.59**	-0.03
<b>Child Nutrition</b>			
% malnourished (weight for age at < - 2 sd of WHO median)	8.6%**	-2.1%	3.1%
% of children stunted (height for age at < - 2 sd of WHO median)	-2.1%	9.0%	10.4%
% of children wasted (weight for height at < - 2 sd of WHO median)	-3.3%	-9.70%	2.70%

## Learnings and Recommendations for Programmatic Focus

Overall, this study has helped us gain invaluable insights on our program impact as well as a deeper understanding of farmers and their priorities. We also benefited from a unique understanding of farmer behaviour during seasonal fluctuations, which we could only have discerned through a longitudinal study. Over the next few months, we will also be looking at the results of the study in greater detail to uncover other areas for programmatic improvements in addition to the changes that have already been set in motion through headline findings around nutrition, resilience and asset- building in previous years of this study.

**Targeted Nutrition Interventions:** The study has shown that decreased hunger does not immediately lead to better nutrition outcomes and dietary diversity. Instead, it generates a tangible impact on nutrition requires more targeted interventions that move beyond eradicating hunger. Improving nutrition outcomes for our clients and their families is already an impact priority for One Acre Fund. We have now ramped up our investments in a range of health and dietary interventions such as better nutrition and behavior change

training as well as innovations in products such as poultry, health insurance, and others to improve household nutrition and growth. We have also started ambitious programs in Kenya to directly tackle nutrition outcomes for children under five and pregnant mothers.

**Building Farmer Resilience:** The 2016 drought was a stark reminder of just how smallholder farmers are vulnerable to income and agricultural shocks. With the realities of climate change, building farmer resilience is more important than ever. We have galvanized our focus on not just building farmer income, but also farmer resilience. Some of the areas that One Acre Fund is already considering as part of resilience building are below.

- *Soil Health.* Healthy soil, particularly physically healthy soil (e.g. soil structure, texture, bulk density, and infiltration), is better able to retain moisture, which helps mitigate the effects of drought.
- *Crop Genetic Diversity.* Different crops and crop varieties are affected by growing conditions in different ways. Diversified genetics (within and across species) hedge against shocks that may be brought on by climate change. As an organization, we are also making significant investments in enabling our farmers to build their agroforestry assets and improve their crop diversity. These areas can also provide useful income diversity especially during difficult periods.
- *Livestock Investment.* Livestock are an important source of farm income and soil health. As we have seen in this study, they act as both a productive asset and a form of insurance that can be sold under adverse conditions.
- *Monitoring & Analysis for better program design.* By monitoring weather patterns and projecting effects of climate on our clients' crop systems, we may be able to tailor products or seasonal recommendations to help farmers plan better, and we could target our R&D work better.

**Crop Insurance:** Building on the recommendation of resilience, it is important to create a safety net for our clients. While we can promote innovations to farmers that reduce climate change risks, vulnerabilities will always remain. Insurance products that further reduce this risk, particularly in the case of catastrophic events, can go beyond the limitations of agricultural technologies. One Acre Fund already provides crop insurance for its clients which can go a long way in insulating them from agricultural shocks. However, insurance for smallholding agriculture is tricky and also difficult to implement perfectly. We still need to perfect the insurance offerings that we offer at such a large scale so that they can meaningfully insulate farmers from agricultural shocks.

**Fortifying Agricultural Income:** Our findings from the study show that farmers prefer to re-invest agricultural profits back into farming or businesses that are offshoots from agriculture (such as selling food grains, rearing livestock, and selling their produce). One Acre Fund can explore how to continue supporting farmers as they move to higher degrees of agricultural investment through participation in the One Acre Fund program. Currently, One Acre Fund already encourages farmers to expand their package size incrementally as they spend longer in the program (and are, therefore, able to invest more in agriculture). As we find that the One Acre Fund program motivates farmers to deepen their roots within agriculture, it is even more important to explore more ways to help them maximize agricultural profit with better market access programs and income avenues that complement agriculture such as livestock rearing. We also know, as illustrated by the 2016 drought, that smallholding agriculture is inherently risky and reliant on the vagaries of weather patterns. Given the realities of climate change, it is more critical than ever to explore programs that insulate farmers (to the possible extent) from such agricultural shocks by promoting drought-resistant crops, or even irrigation. One Acre Fund already has made some progress in this regard. For example, One

Acre Fund farmers are encouraged to use lime which helps keep soil acidity levels under control. In 2018, 26% of total clients in Kenya adopted lime which will be a big contributor to long-term soil health.

## ANNEXURE

### ANNEX A: Background and Program Description

Farmers make up 70% of the world's poor. Yet most of them live in remote areas and do not have access to basic agricultural resources and training. As a result, they struggle to grow enough to feed their families and face an annual hunger season, where one in ten children do not survive due to malnutrition. Year after year, farmers find themselves trapped in a cycle of low yields and compounding poverty.

Specifically, many rural smallholders lack access to improved farming technology due to financial constraints, geographic isolation and lack of training programs. Founded in Kenya in 2006, One Acre Fund provides a bundle of services to address these barriers to improved yields. Farmers are provided with seed and fertilizer, on credit, and allowed to pay back on a flexible repayment schedule throughout the season. They organise into groups and are jointly responsible for repayment. They are given regular training, which covers topics such as optimal planting practices, fertilizer application, pest management, and safe storage of harvest. Farmers are also provided crop insurance and given the option to purchase other products with proven income and/or quality of life impacts, such as solar lamps (our most popular add-on product) as well as cookstoves.

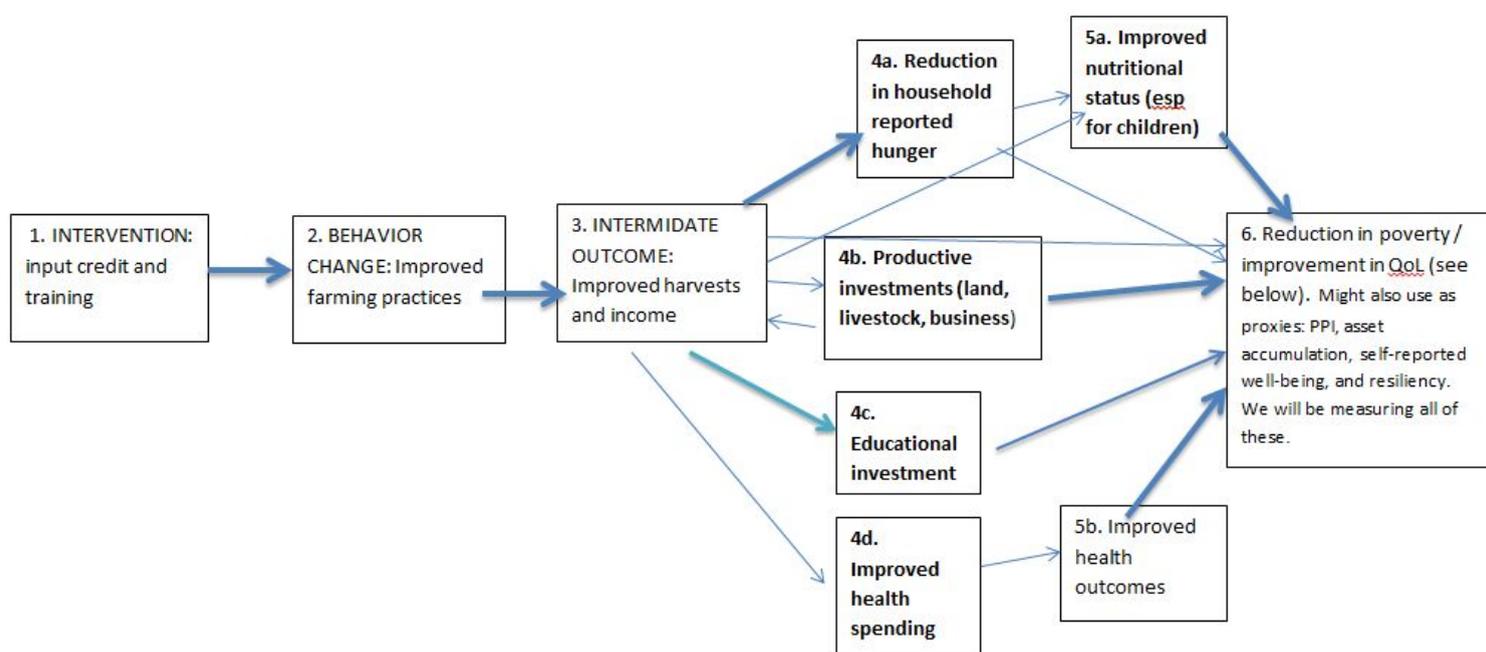
One Acre Fund's core program in Kenya is spread across the Western and Nyanza provinces which represent different agro-economic conditions. Here, altitude can range between 1,227 and 1,914 meters with annual rainfall ranging between 1,028 and 2,112 mm. Farmers enrolled in the Kenya program usually plant their crops on 1.3 acres of land, of which 0.6 acres are allotted, on average, to program-specific inputs. The program enrolls farmers one season each year and includes a core package of seed and fertilizer inclusive of training. Neighboring farmers have relatively low fertilizer use and access to similar training. Therefore, we expect (and have seen historically) program effects are relatively higher in Kenya (compared to other One Acre Fund countries).

One Acre Fund's Rwanda program is similar to Kenya's but farmers there face different agricultural environment and available resources differ from those in Kenya. Here, the core program is spread over across different agro-economic conditions except in the Northwest region where the altitude can range from 800 and 4,480 meters with annual rainfall between 378 and 2,564 mm depending on the region. The farmers enrolled in the Rwanda program usually plant their crops on a single acre of land out of which 0.4 acres are allotted, on average, to the program-specific inputs. The Rwanda program enrolls farmers for two seasons each year and includes a package of fertilizer (but not seed in most areas) with training. Unlike in Kenya, neighboring farmers have decent access to fertilizer through agro-dealers and One Acre Fund also runs an agro-dealer program in the areas where we operate to ensure quality fertilizer and timely delivery to any farmer regardless of their program enrollment. One Acre Fund also has partnered with the government to improve extension services in the country, which are intended to reach every single village. One Acre Fund has provided training tools and checklists to "farmer promoters" who, in turn, pass on this knowledge to farmers in their home sites. Given this comprehensive agricultural support which includes access to fertilizer and training among control farmers we do not expect program impacts of our program (excluding government-partnership programs) to be as large in Rwanda compared to Kenya.

One Acre Fund's activities aim to bring changes with an ultimate goal of reducing poverty and improving the quality of life for our farmer-clients. Below is One Acre Fund's theory of change, focused on our core target

population of farmers and their families. It moves from our direct program components to behavior change to increases in harvests and incomes all represented in the blue boxes. We have measured our impact on each of these fronts, keeping careful track of our program components, through Key Performance Indicators of farmers' behavior change through planting compliance surveys and direct outcomes through our annual impact assessments.

Less known are our theorized improvements in other aspects of farmers' lives which are often interrelated, and which we hope will ultimately lead to a reduction in poverty and contribute to improvements in quality of life for our clients.



The bolder arrows represent more established links

- From 1-2: We regularly assess this in our planting compliance survey in each country and confirm high compliance with our practices. In 2014, we took this a step further a) assessing the spillover of our practices to neighboring farmers and b) looked at the degree to which ex-clients are retaining our practices. The two studies show that program spillover is happening to control farmers and ex-clients demonstrating higher compliance for better agricultural practice and better maize yields than farmers who never participated in the program.
- From 2-3: We regularly assess improvements in yields and profits as part of our annual impact assessments. Comparing One Acre Fund and non-One Acre Fund farmers we have regularly measured improvement in yields and profits from 10% to 100%, but typically about 30-50% per farmer.
- From 3-4a: We have done some initial assessments of harvest yields on hunger outcomes (maize remaining in-store and FANTA scales) and have detected a strong statistically-significant relationship for each assessment (effect size of 0.33 in grain stored and FANTA effect size of 0.25 - 0.5.)

- From 3-4b. We know less about the magnitude and diversity of other investments (business, farm, livestock etc.)
- From 3-4c. We have one study (CEGA 2012) showing improvements in educational expenditures, however, this could be explored further
- From 3-4d. We have little internal data on any changes in health spending or resilience to health shocks.
- From 3 – 5a. There’s a paucity of literature on the links between agricultural interventions and nutrition alleviation.
  
- From 4a – 5a: reduction in hunger should logically lead to improvements in malnutrition. However, this is likely mitigated by the distribution of resources within the household. (e.g. children are most susceptible to malnutrition, but when household hunger improves, this might not improve their outcomes if they do not receive a significant piece of the pie) as well as the type of food eaten (if certain vitamins are lacking hunger will not improve some nutritional outcomes)
  
- From 4b – 5b: Presumably increased health spending should lead to improved health outcomes. However, this will vary greatly depending on the quality of care in each environment. (there’s a rich body of literature here where we can investigate more)

**This last link towards “quality of life” is tougher to define, possibly we can use the PPI, but that is mainly an income proxy. In fact, it’s a way to describe all the underlying factors, which are interlinking and all show evidence that they can be strong pathways out of intergenerational poverty**

- From 4a – 6: Hunger alleviation. By causing poor health, small body size, low levels of energy, and reductions in mental functioning, hunger can lead to even greater poverty by reducing people's ability to work and learn, thus leading to even greater hunger. (See Victoria et al. [2008](#))
- From 5a – 6: Ameliorating malnutrition. Stunted children suffer IQ loss, a higher likelihood of entering school and not completing basic education, as well as later onset of nutrition-related chronic diseases (diabetes, hypertension, heart disease among others) that lead to early death, diminished quality of life without needed health care services because of income constraints. (See [Hunt 2005](#))
- From 4b – 6: Productive investments. (can divide into agriculture, livestock and small business) See this [working paper](#) on livestock investments, and [Shchneider and Gugerty 2011](#) on ag investments. Lots of research on the importance of small business for poverty alleviation.
- From 4c – 6: There is a large body of evidence that more access to education leads to long-term poverty reduction (see [Dercon & Shapiro 2007](#)).
- From 5b – 6: Better health outcomes are strongly linked with better ability to escape poverty (see [Dercon & Shapiro 2007](#)). Also, the WHO says: “illness can reduce household savings, lower learning ability, reduce productivity, and lead to a diminished quality of life, thereby perpetuating or even increasing poverty”
- From 3-6: Agricultural productivity to poverty alleviation: There are established linkages between increases in agricultural productivity and poverty reduction. The evidence suggests that there are multiple pathways through which increases in agricultural productivity can reduce poverty, including real income changes, employment generation, rural non-farm multiplier effects, and food prices effects. (see [Shchneider and Gugerty 2011](#). Also, see [IFPRI’s analysis](#) on halving African poverty by increasing investments in agriculture at the macro level.)

## Annex B. Site Selection

The overall evaluation approach we took is a difference-in-difference design with propensity score matching, where geography is used to narrow the pool of potential treatment and comparison farmers. We select control farmers from just beyond a relatively arbitrary boundary, beyond which we do not offer our program and treatment farmers from the other side of that boundary.

In selecting sites for our study, we consider the following criteria:

- Relatively new areas of our program (so we can catch farmers on the bottom of the curve of any potential upward trajectory).
- Not an “outlier” area in terms of agro-ecological conditions or farmers demographics, so that it is fairly typical of program performance.
- Not an area in which we are running many program trials so that the program intervention is fairly typical of our program overall.
- Cluster of sites to one side of an area where we are willing to hold off expansion
- No major known problem with staff performance in the area.
- Border area should not be a stream, road or meaningful administrative boundary but as arbitrary as possible.

## ANNEX C: Potential Risks and Mitigation

In the study design, we had anticipated the likelihood of program attrition (both from the study as well as the program) over the 4-year study duration. We also considered the possibility of contamination (controls migrating into the program) taking place. We have noticed some attrition and spillover after one year of the study. This does not have any bearing on the analysis of the first year of the study. However, this will factor into our analysis in the third round of data collection. The details and implications are listed below.

### *Contaminated controls*

After the first year, 116 control farmers (out of a total of 1200 of them), crossed over the program border to enrol in the One Acre Fund program. While these “contaminated” farmers would not have seen the benefits of the One Acre Fund program during second round data collection, they are excluded from the analysis from the third round onwards. The M&E team worked very closely with the Kenya Field team to ensure that control farmers were not enrolled in the program for the remaining years of the study. Contaminated farmers were held off until the issue was identified.

### *Study Attrition*

The enumerators of the study tried to reach out to each farmer in the study. At least three attempts were made to visit every farmer and encourage them to undertake the survey. Eventually, 379 farmers could not be reached for the second or third (or both) rounds of data collection. This is because they may have moved away, died, or declined to take the survey again.

### *Program Attrition*

**Kenya:** Around 419 One Acre Fund farmers left the program after two years of participation. This is roughly what we had expected in terms of attrition. We did not expect all farmers to continue with the program for the entire duration of the study.

## **ANNEX D. Analysis Strategy – Differences-in-Difference and Propensity Score Matching**

Difference-in-Difference: Despite the careful site selection and sample strategy in order to minimize bias, the balance tests conducted at baseline show some differences between control and program farmers. To overcome this, we have used Difference-in-differences (DD) and Propensity Score Matching (PSM) to eliminate bias. This helps control for differences and enable us to estimate more accurate impact. DD estimation helps control factors (both observed and unobserved) that do not change over time and may influence outcomes. These factors can be age, education level and the risk-aversion profile of a farmer. PSM allows us to refine control farmers based on characteristics to make them as comparable to One Acre Fund farmers as is possible.

DD might be problematic if only one group has been affected by an event (eg. violation of parallel trends assumption). PSM heavily depends on its model. Depending on certain factors required to compute a propensity score, the model can be unbalanced between two groups and sensitive to factors that are excluded in the model and also influence outcome variables. We thoroughly checked each model's balance and sensitivity throughout our analysis and are confident that they were well-constructed.

Propensity Score Matching: We have also used Propensity Score Matching as a control refinement technique to smooth out differences between treatment and control farmers. We have used nearest neighbor matching (up to two matches) for the matching model. We have found the models to be well balanced with adequate common support area.

Treatment of Outliers: Self-reported data on expenditures and income are notoriously difficult to collect.<sup>6</sup> Precise estimates can be difficult for respondents to recall and there are possible biases at play. Respondents might have an incentive to under-report income, for example, with the assumption that this might qualify them for a social program or to over-report due to shame about their circumstances. We have attempted to minimize these biases as much as possible by reassuring respondents about the confidentiality of their responses and by assuring them that nothing they say will qualify or disqualify them for any program benefits. Furthermore, where possible, some of the questions related to recall have been kept to a time period of two weeks at most to obtain more accurate information. In addition, for income and expenditure data, which had long tails at either end of their data distribution, we have **winsorized outliers to two times the average standard deviation** in order to better identify real differences among our study groups<sup>7</sup>. For variables with high variance, outliers were identified as those that were more than two times the standard deviation of the variable. The results for such data have been reported without the outliers. Information on results with the outliers can be shared on request.

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<sup>6</sup> See "Assessing the Reliability of Household Expenditure Data: Results of the World Health Survey" World Health Organization. Discussion Paper #5, 2007

<sup>7</sup> At the baseline, we had used the strategy of dropping outliers. However, we lost a lot of data points using this strategy. We prefer the method of winsorizing outliers instead which replaces the outliers with the value at the outlier cut-off point (e.g. + 2 times the standard deviation, but does not exclude the data points from the analysis).

Multiple Hypothesis Issues: We will be testing numerous hypotheses to understand the impact of the One Acre Fund program on all aspects of the life of farmers and their families. Given the sheer number of variables being tested, it is possible that some outcomes are statistically significant by chance. This is especially the case when we test changes in almost 100 individual assets and consumption patterns. To overcome this, we will look at index variables, where relevant, that represent the sum of total asset type and consumption patterns for different time periods.

## ANNEX E. ANOMALOUS HUNGER OUTCOMES

Food Security - Difference in Change Over Time for One Acre Fund vs Control Farmers				
Outcomes of Interest	Difference at baseline	Difference in Difference		
	2015	2016	2017	2018
Year compared to the baseline				
% who have maize remaining	<b>10.1%***</b>	<b>18.1%***</b>	<b>-11.0%**</b> *	<b>22.8%***</b>
Total amount of maize harvest remaining (kg)	<b>12.21**</b>	19.8*	<b>-13.33***</b>	16.5*
Total amount of maize harvest remaining (kg per acre)	22.1	36.2	<b>-32.74**</b>	38.9
Dietary Diversity (higher score indicates a more diverse diet)	<b>0.312**</b>	-3.60%	-0.111	0.25
<b><i>For the outcomes below a negative number indicates a positive program effect</i></b>				
Percent reporting "severe hunger season" (reported they almost never had enough to eat)	-3.5%*	-3.0%	4.70%	2.28%
Months of reported hunger season	<b>-0.562***</b>	<b>-0.39**</b>	0.343	0.445
Fanta score (higher score indicates greater hunger)	<b>-0.593***</b>	-0.08	<b>0.620***</b>	0.298*
% who had no food to eat because of lack of resources (in the past 30 days)	<b>-35.9%***</b>	3.80%	<b>45.6%***</b>	<b>23%**</b>
% of HHs' where a member slept hungry because there was not enough food (in past 30 days)	<b>-13.5%**</b>	-10.5%**	11.7%*	-3%
% of HH where a member went the whole day and night without eating anything because there was not enough food (in past 30 days)	<b>-10%***</b>	<b>-1.10%</b>	4.7%	<b>9%***</b>
*** p<0.01, ** p<0.05, * p<0.1				