

# One Acre Fund

## Quality of Life Study Kenya: Year 3 Results



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## Executive Summary

For years, One Acre Fund (1AF) has rigorously tested the impact of its program on harvest yields and profits of participating farmers. However, in 2015, the organization had less information on the ways in which the program was impacting other facets of farmers' lives. For example, One Acre Fund wanted to know the ways in which farmers invested extra income, whether these investments led to better life prospects, and how the program affected aspects like health, education, and nutritional status. To better understand the impact on farmers' lives, One Acre Fund initiated a longitudinal "Quality of Life" study. As mentioned in our pre-analysis plan<sup>1</sup>, the main purpose of the study was to discern the secondary outcomes of the program, with an understanding that it might be unlikely that we would find statistically significant results in all of the outcomes under study.

**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 comparison 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 comparison 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>2</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 1AF farmers in comparison to non-participating 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, 1AF farmers saw a **significant increase in agricultural productivity and a decrease in hunger relative to comparisons 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

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<sup>1</sup> The pre-analysis plan is available upon request.

<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. In Year 2, our qualitative analysis in Rwanda revealed that treatment and comparison sites faced dissimilar external shocks between 2016 and 2017 which could have varying impact on the quality of life outcomes for these two sites.

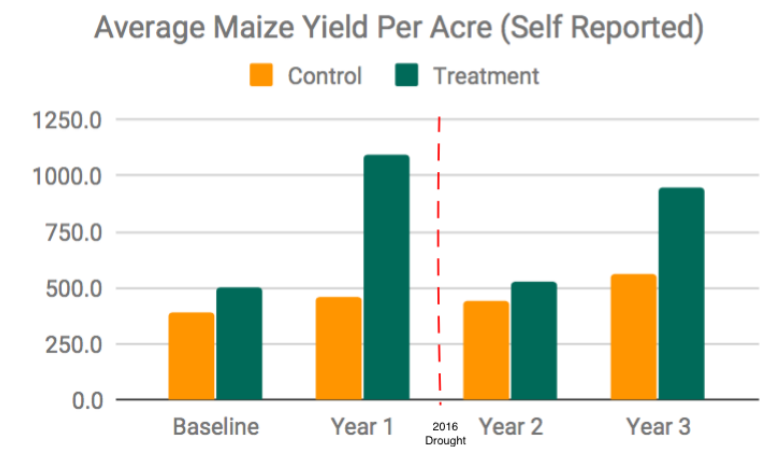
harvest). Surprisingly, we did not see much increase in educational outcomes for the children in 1AF households. In Kenya, this was likely due to the fact that baseline educational attendance was already quite high. Although there was **no change in consumption patterns in Kenya**; in Rwanda, we saw 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 comparison farmers. This can probably be attributed to increased agricultural productivity, 1AF farmers in Kenya and Rwanda also reported **relying less on non-agricultural income streams over the study period** (as compared to comparison farmers). **A higher share of children in 1AF 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 were below average. This resulted in severe drought which also had an adverse effect on crop yields that season 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 1AF 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 1AF 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 1AF 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 1AF 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.

**Table 1 below presents the summary findings from the analysis in Kenya. We find a relatively strong increase in maize productivity for 1AF farmers - when both farmers self-reported and physically measured.** This led to an increase in maize income by \$99.3 for 1AF farmers in treatment areas compared to non1AF farmers. When we look at percentage improvements for farmers, this represents a 39% increase in maize profit. 1AF farmers also **increased the total area cultivated for agriculture** (top four crops) by 0.44 acres compared to non-1AF farmers 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.**

**Graph 1: Trends in maize productivity per acre**



**1AF farmers increased their overall, physical and livestock assets value** compared to non1AF farmers 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, which was eight to nine months after harvest. However, we hypothesized that this was likely because any consumption boost had dissipated so many months after the harvest. So, we added a consumption 2-3 months after harvest and found that 1AF actually had an impact on the **consumption of food in the past two days**.

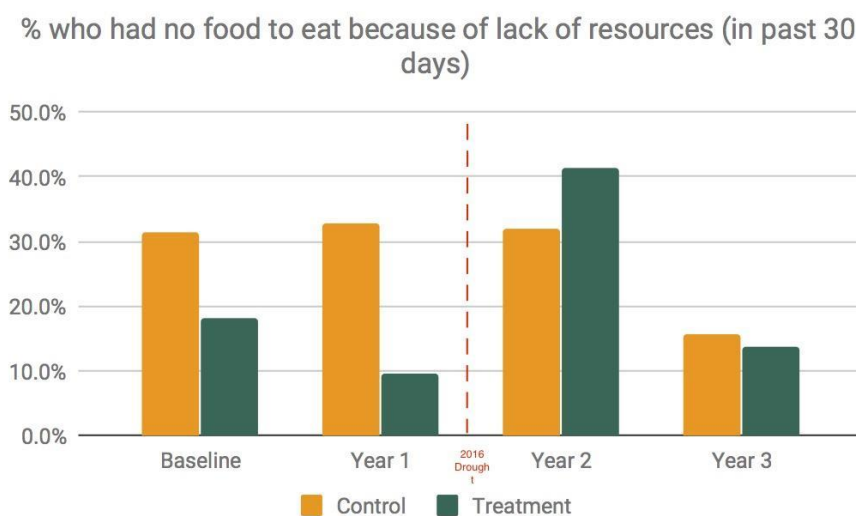
Although we find no statistically significant impact on the FANTA score, Surprisingly, we find evidence of a negative impact on hunger for 1AF farmers compared to comparison farmers on two of the three self-reported hunger indicators that roll into the FANTA score. At the baseline, self-reported hunger levels for comparison farmers were already much higher than 1AF farmers and after three years, non1AF still reported slightly higher hunger than 1AF farmers. **Both 1AF farmers and non1AF farmers experienced a decrease in hunger** over three years of the study. However, **comparison farmers had a much larger decrease in self-reported hunger than 1AF farmers**. Looking at the graph below, it is clear that 1AF 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 comparison 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.

There is another indication that these results are a **violation of the parallel trends assumption**<sup>3</sup>. It might be easier to reduce on hunger, when baseline hunger levels are high, as compared to lower hunger levels. We do know that 1AF farmers were generally slightly more wealthy and less hungry than non1AF farmers at baseline. Although the difference-in-difference method can mitigate such baseline imbalances in wealth and hunger, it does not eliminate the fact that **farmers might behave differently over time based on baseline characteristics**. To test this, we compared a “high” and “low” poverty group over the same time period to see if their trends move in parallel (a basic assumption of the difference-in-difference design). Specifically, we

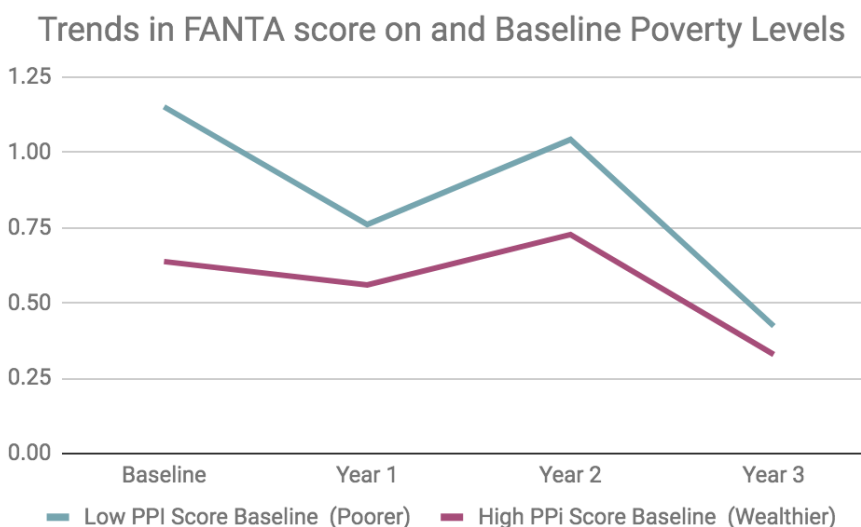
<sup>3</sup> The parallel trends assumption is one of the basic tenets of carrying out a DID estimation. It assumes that any external shock affects both groups in the same direction and similar magnitude.

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 were classified as wealthier. The classification did not depend on program participation. 1AF and non1AF 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.**

**Graph: Trends in food access and resource constraints and 1AF participation**



**Graph: 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 into” agriculture and away**

**from non-agricultural businesses** compared to non-1AF farmers. This is represented by a decrease in business activity and business profits for 1AF 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 1AF 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.

*“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, 1AF 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, 1AF Clients, Eluche, Kenya)*

1AF farmers also reported a decrease in their self-reported cash 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, 1AF Clients, Eluche, Kenya)*

In other exploratory areas, **1AF farmers reported much less stress** than comparisons over the study period. We did not detect any impact in other areas such as financial literacy, women’s economic empowerment, or health outcomes.

**Programmatic Learning’s and Changes:** Overall, this study has helped us gain invaluable insights on our program impact as well as provided a deeper understanding of farmers and their priorities. It largely confirmed our existing impact areas of improved farm yields, farm profits, and land cultivated. We were also able to rigorously test new impact areas that we had only hypothesized before the study such as improving asset ownership, consumption during harvest season, and farmers’ well being. At the same time, the study did not demonstrate impact in areas we where we thought we might see some improvements but were not certain; for instance, diet diversity, health, crop diversity, and income diversity. We are also more aware that decreased hunger does not immediately lead to better nutrition outcomes and dietary diversity.

The study was incredibly valuable in encouraging 1AF to increase investments in these areas. For instance, 1AF has placed a greater a major emphasis on nutrition and behavior change training and products intended to improve diet diversity, health insurance, and nutritious crop rollouts. We have also started ambitious programs in Kenya that directly tackle nutrition outcomes for children under five and pregnant women.

We have galvanized our efforts in not just building farmer income but resilience to external shocks. To achieve this, One Acre Fund's leadership has committed to improving the crop insurance options that we offer 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 to bolster crop diversity. These areas provide additional income during financially difficult periods. Since this study began, the 1AF network has grown from 305,000 to 809,000 farm families. As a result of the increased scale of the program, these new interventions are now benefiting significantly more smallholder farmers and more than 3 million children that are part of these households.

**Learning's Related to Conducting a Longitudinal Study:** This study was one of our most ambitious attempts at conducting a longitudinal investigation with a large sample of farmers. At the start of the study, we had also engaged external researchers and organizations to ensure that our methodology was appropriate due to the scope of the project. As we conclude this study, we also share some lessons learned on conducting a longitudinal study of this magnitude.

An area of our longitudinal methodological learning is related to program attrition. Our program attrition in Rwanda was much higher than anticipated, making it difficult for us to continue the study in the country. In 2015, we did not have the sophisticated farmer-tracking systems in place that we do now in order to have an accurate understanding of this .

Another area is a deeper understanding of the parallel trends assumption<sup>4</sup>. Of course, we were aware that the violation of this assumption could be a threat to the study design and we chose our comparison areas to be immediately adjacent to our treatment sites so that we could study both under similar external conditions. However, the assumption was violated in Rwanda due to micro-climatic conditions and village-specific programs. Another parallel trends violation that we had not anticipated was that some farmers might react to external shocks (like droughts) or secondary impacts (like hunger perception) differently based on their baseline characteristics (like income levels).

This study has illustrated the importance of tracking holistic impact regularly. We are now shifting our focus on holistic impact understanding by surveying quality of life changes in a quicker and leaner manner through more frequent "Mini Quality of Life" surveys. We have expanded these surveys to all 1AF core countries of operation so that our impact understanding is geographically diverse. In these mini-surveys, we conduct assessments between veteran 1AF and newly enrolled 1AF farmers to understand programmatic impact. Since we reach a farmer only once, these surveys are less susceptible to the longitudinal study design issues noted in this report and results are available to analyze much faster.

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<sup>4</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.

**TABLE 1: 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>. 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>			
<b>Agriculture and Maize Profit</b>	<p><b>Harvest size:</b> Farmer's self-reported a high increase in maize yield for 1AF farmers by 375 kg more than non1AF farmers. Controlling for land size, this translated into 274 kg per acre more than non1AF farmers. Physical measurement of harvests for 1AF clients revealed even greater results - these farmers harvested 371.8 kg per acre more than comparison farmers.</p>		
	<p><b>Land Size Cultivated:</b> 1AF farmers increased their total area cultivated for agriculture (top four crops) by 0.44 acres compared to non1AF farmers over the three years under study. This provides further evidence that program farmers are "leaning in" to agriculture.</p>		
<b>Hunger</b>	<p><b>Maize Surplus during Hunger Season:</b> As a result of the increase in maize harvest due to program participation, 1AF farmers were 31.7% 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 1AF farmers had 19.3 kg of total maize more than comparison farmers 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>		
<b>Education</b>	<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 between 5 and 18 years of age of clients studied 0.16 hours more, on average, compared to children in comparison 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>		
<b>Assets</b>	<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 1AF 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 1AF farmers.</p>		
	<p><b>Total Financial Assets:</b> No evidence of impact in this study.</p>		
<b>Consumption</b>	<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. 1AF households consumed food worth \$1.6 more than non1AF farmers in the past two days. We believe to be a more modest representation of our impact because 1AF farmers might behave differently with the seasonal fluctuations than comparison farmers.</p>		



Income	<b>Maize Income:</b> We estimate that 1AF farmers in study areas had an increase in their maize profit by \$99.3 compared to non1AF 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 1AF 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> 1AF farmers reported a decrease in income of \$10.1 as compared to non1AF farmers during the past 2 weeks at the time of the survey in the hunger season. This was mainly driven by a decrease in daily wages business profit for 1AF farmers because of their reduced investments in that area. We have detected a decrease in wage income in all three years of the study. The qualitative inquiry showed that wage labor during the hunger season was a strategy of desperation which 1AF 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> 1AF farmers in Kenya reported much less stress of 1.2 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.
Financial Literacy	<b>Total Budget and Planning Score:</b> No evidence for impact in this study
	<b>Crop Diversity Attitudes:</b> Surprisingly, 1AF farmers were more likely to prefer planting single than multiple crops than non1AF farmers by 22 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 crop diversity for 1AF 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> We find a decrease in child malnourishment rates by 20% pts. However, we consider that a statistical anomaly because none of the remaining indicators point towards enhanced nutrition outcomes.

<b>ONE ACRE FUND - LONGITUDINAL QUALITY OF LIFE STUDY IN KENYA defined.</b>	<b>Error! Bookmark not</b>
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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>5</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 comparison 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 comparison group which did not self-select into the program), and (2) to be operating in a similar environment to comparison 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 comparison 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 comparisons 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 comparison farmers were selected from just across the program boundary with very similar characteristics to the 1AF farmers. At the baseline, we found some differences between 1AF and non1AF farmers. Compared to non1AF farmers, 1AF 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 comparison group was adequately comparable to the treatment group.<sup>6</sup>

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<sup>5</sup> For a detailed description of the program in Kenya, please refer to Appendix A.

<sup>6</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.

### ***Multiple Hypothesis Issues***

We will be testing numerous hypotheses to understand the impact of the 1AF 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.

### ***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 .

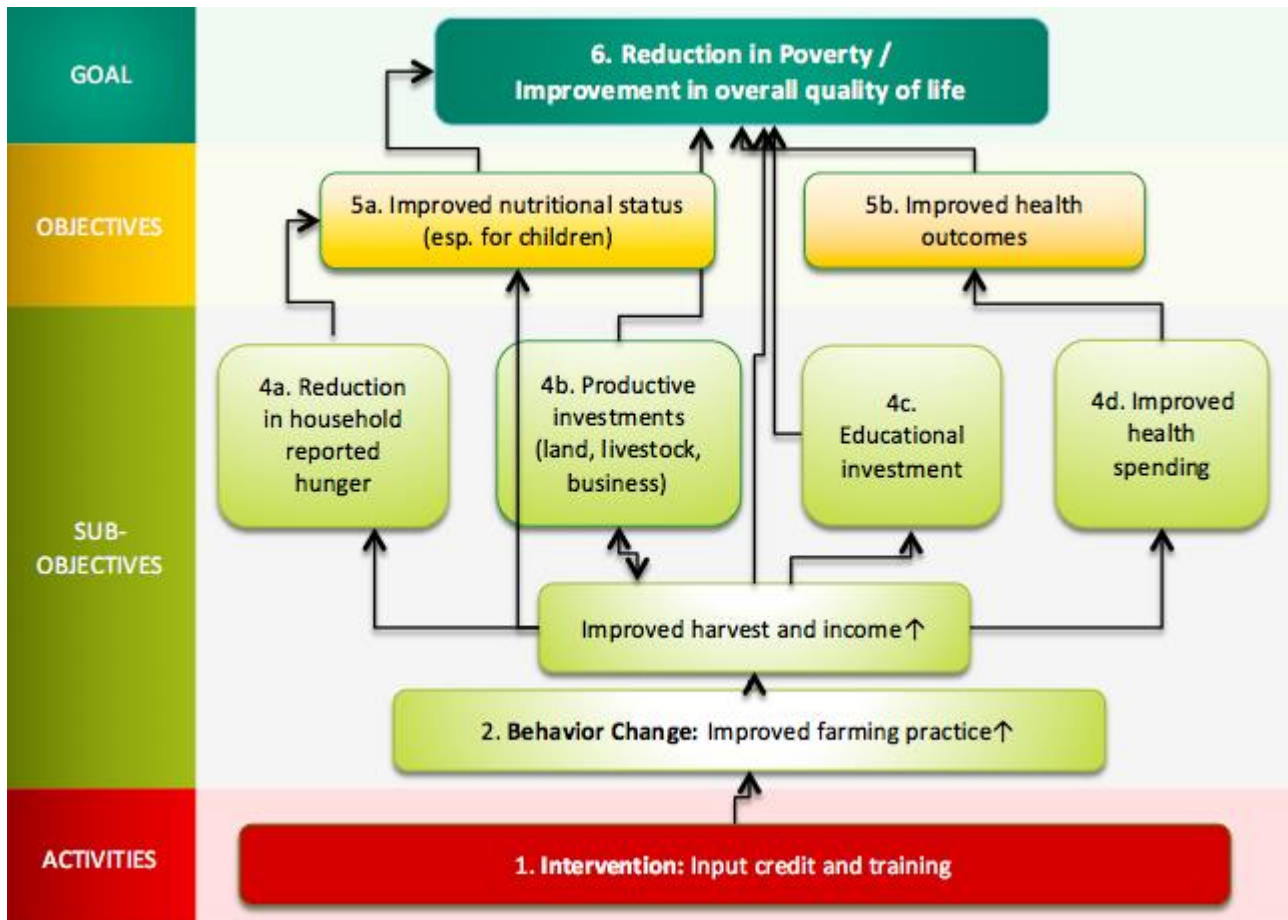
### **Note on Presentation of Analysis**

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 1AF farmers in comparison to non1AF 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, if at all. 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.

Graph 3: Theory of Change



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 non1AF farmers 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 1AF 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 comparison farmers. Perhaps due to increased agricultural productivity, 1AF farmers in Kenya and Rwanda also reported relying less on non-agricultural income streams over the study period (as compared to non1AF farmers). A higher share of children in 1AF households were reported to be consuming more nutritious food items such as milk (in Kenya) and fish and meat (in Rwanda).

Our ability to programatically achieve, and rigorously measure, program impacts depends 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 was below average. This resulted in a severe drought in most 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 1AF 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>7</sup>: Our qualitative analysis (interviews with village chiefs) in Rwanda study areas revealed that treatment and comparison sites faced dissimilar external shocks between 2016 and 2017. Treatment sites were more likely to face drought and pests than comparison sites in 2017. On the other hand, comparison 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 1AF 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 1AF 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 (1AF). 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 1AF 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.

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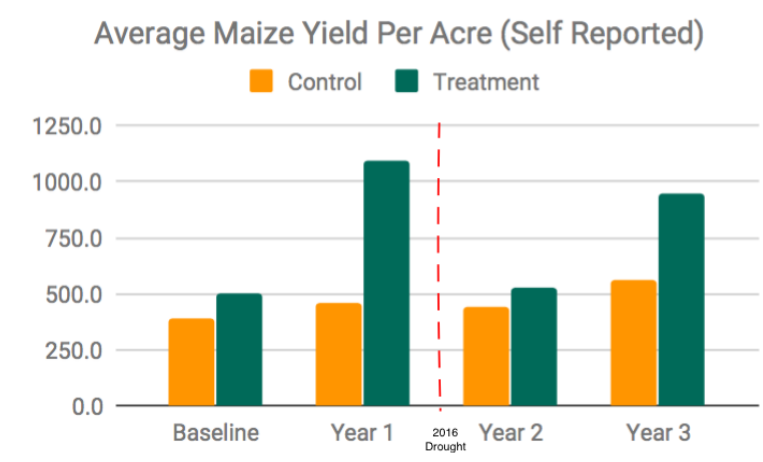
<sup>7</sup> The parallel trends assumption is one of the basic tenets of carrying out a DID estimation. It assumes that any external shock affects both groups in the same direction and similar magnitude.

## 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 1AF farmers in Kenya. The self-reported results show that 1AF 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 1AF team in the area for a subset of participants in the study. In 2017, 258 farmers participated in the physical harvest measurement of which, 92 were 1AF farmers and 166 were comparison farmers. We found that, on average, 1AF farmers harvested 371.8 kg per acre more than non1AF farmers. The average yield for non1AF farmers was 1015 kg per acre, whereas 1AF farmers in the study had an average maize yield of 1386.7 kg per acre.

**Graph: Trends in Average Maize Yields (Self Reported by Farmers)**



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 1AF 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 impact on agricultural practices and yields for 1AF 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:** 1AF farmers also increased the total area cultivated for agriculture (top four crops) by 0.44 acres compared to non1AF farmers 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 widening clients' agriculture base.

Agricultural Outcomes - Difference in Change Over Time for 1AF vs non1AF Farmers			
Outcomes of Interest			
Year compared to the baseline	2016	2017	2018
Total Maize Yield per Farmer (kg)	248.3***	-31.28	374.9***
Maize Yield Per Acre (kg per acre)	402.5***	86.99***	273.9***
Total Area Cultivated (4 main crops)	0.304***	0.368***	0.438***
% who evaluated good harvest (Maize)	44%***	-2.60%	20.2%***
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, 1AF estimated program impact by comparing 1AF farmers' profit from harvests with those of non-1AF farmers'. In this section, we also 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 non1AF 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 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.



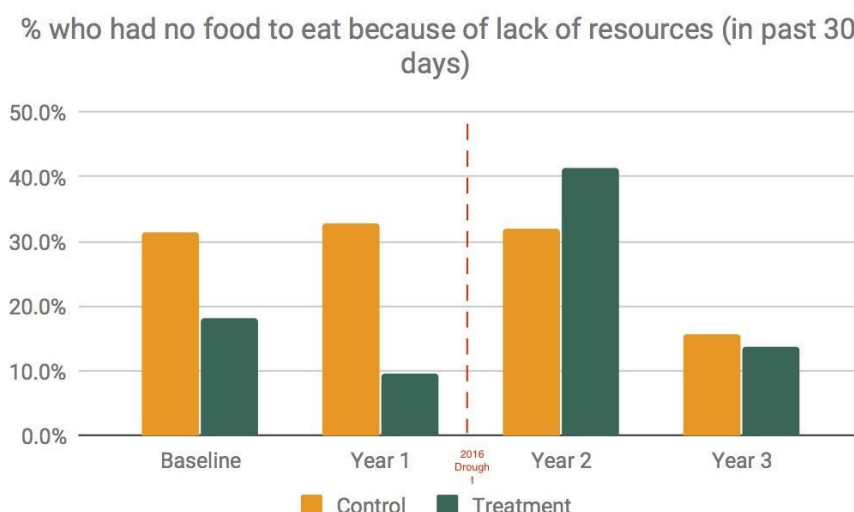
**Maize Remaining during Hunger Season:** As a result of the increase in maize harvest due to program participation, 1AF farmers were 31.7% pts. more likely to have maize remaining from their harvest during the hunger season. Relatedly, there is weak evidence ( $p < 0.1$ ) that 1AF farmers had 19.3 kg of total maize more than non1AF farmers 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 stay on the positive side, the impact on dietary diversity is no longer significant in Year 2 or Year 3 of the study.

**FANTA Score:** There are three indicators that comprise the FANTA score. Although we don't find any statistically significant impact on the main FANTA score, we find evidence of negative impact on two of the three indicators that measure self-reported hunger (these three indicators make up the final FANTA score) for 1AF farmers compared to non1AF farmers. At the baseline, hunger levels for comparison farmers were already much higher than 1AF farmers and, after three years, non1AF farmers still reported higher hunger than 1AF farmers. Over the three year period, **both 1AF farmers and comparison farmers experienced a decrease in hunger. However, comparison farmers still had a much larger decrease in hunger than 1AF farmers.**

There is a rather peculiar trend in hunger for non1AF farmers in relation to the agricultural year. Looking at the graph below, it is clear that 1AF 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 non1AF 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.

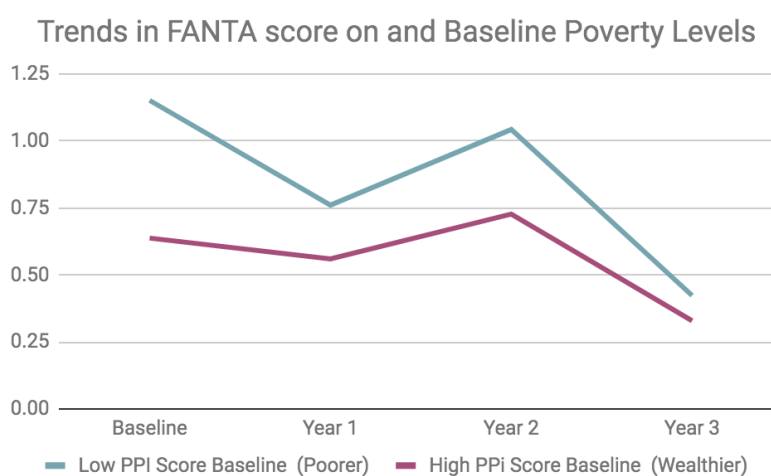
**Graph: Trends in Food Access and Resource Constraints and 1AF Participation**



There is another result which indicates a **violation of the parallel trends assumption**. It might be easier to reduce on hunger, when baseline hunger levels are high, as compared to lower levels. We do know that 1AF farmers were slightly more wealthy than non1AF farmers at the baseline. Although the difference in difference mitigates this baseline imbalance, it does not eliminate the fact that **farmers might behave differently over**

**time based on their baseline characteristics.** To test this, we compared a “high” and “low” poverty group over the same time period to see if their trends move in parallel (a basic assumption of the difference-in-difference design). Specifically, 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 were classified as wealthier. The classification did not depend on program participation. Both 1AF and non1AF 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.**

**Graph: 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 significant impact on most asset indicators. 1AF farmers increased their overall, physical and livestock assets value compared to non1AF farmers 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 1AF program.

Asset - Difference in Change Over Time for 1AF vs non1AF 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>656.7</b>	**
Total Physical Assets Value (without house value) in USD	<b>565.3</b>	*
Total Financial Assets Value in USD	30.94	
Total Livestock Assets Value in USD	<b>91.3</b>	**
*** p<0.01, ** p<0.05, * p<0.1		

## Income

Although we measure increase in maize profit as a result of program participation, we are also interested in understanding 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 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. 1AF farmers continue to be seen as “leaning into” agriculture and away from non-agricultural businesses compared to comparison farmers. As a result of program impact, the share of 1AF 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 non1AF farmers. 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 non1AF farmers’ businesses (who actually also had a slight decrease) but rather by a decrease in the total businesses owned by 1AF farmers.

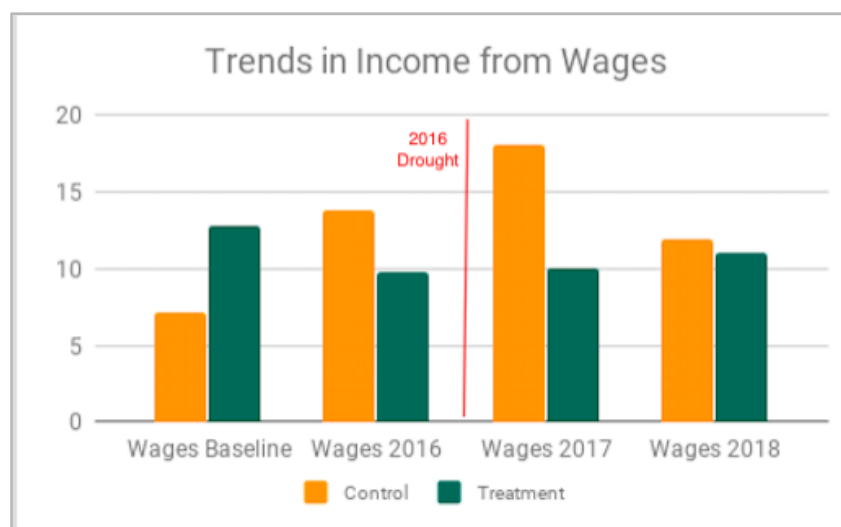
The qualitative analysis in both countries shows us that these findings simply reflect farmer preferences. An increase in agricultural profit does not necessarily provide an impetus to non-agricultural businesses and the relationship is not as linear as we may have believed at the beginning of the study. Most participants reported to prefer 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 1AF and the income earned is used to cater for my domestic needs.” (Female-only focus group, 1AF 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, 1AF Clients, Eluche, Kenya)*

**Maize Annual Income:** As mentioned in the agriculture section, we estimate that 1AF farmers in study areas had an increase in maize profit by \$99.3 compared to non1AF 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):** 1AF farmers reported a decrease in income of \$10 as compared to non1AF farmers in the 2 weeks preceding the survey during the hunger season. This was mainly driven by a decrease in wages and business profit for 1AF 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 and daily wages.



We have found a significant decrease in wage income consistently over the three years of the study. The qualitative inquiry showed that wage labor is more of a strategy of desperation which 1AF 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, 1AF 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, 1AF Clients, Eluche, Kenya)*

Income - Difference in Change Over Time for 1AF vs non1AF Farmers			
Year compared to the baseline	2016	2017	2018 (Annual Study)
Total Income in past two weeks (USD)	-6.9***	-13.62***	-10.1 ***
Total income in the past 2 weeks (excluding remittances - USD)	-5.1***	-11.54***	-9.0 **
<b>Non-Agricultural business</b>			
% of household who have any non-ag business	-4.6%	-13.1%***	-10.1% *
% who receive more than half of income from activities other than farming	-30.4%**	-28.3%***	-31.2% ***
Average business profit per typical farmer in the past month	-5.4*	-5.58	-4.0
Average business profit in the past month (only those who had a business)	-6.8		-5.1
Total # of businesses per household	0.05	-0.17***	-0.15 **
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%	-2.5%
<b>Details of self-reported income (past 2 weeks)</b>			
Wages Income	-2.6*	-5.8***	-6.1 **
Selling Eggs Income	0.04*	-0.06	0.1 *
Selling Milk Income	-0.1	0.03	0.3
Selling Livestock Income	-0.2	-0.21	1.5 *
Selling Grains Income	-0.6	-2.6***	-0.5
Selling Vegetables Income	0.1	0.13	0.1
Remittances Income	-1.8**	-2.1*	-1.1
Business Profit Income	-1.7*	-3***	-4.5 **

\*\*\* 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 1AF 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 1AF farmers might behave differently with the seasonal fluctuations than non1AF farmers.

Consumption - Difference in Change Over Time for 1AF vs non1AF Farmers				
Outcomes of Interest				
Year compared to the baseline	2016	2017	2018	2018 (Mid Cycle Study)
<b>Overall Consumption Value</b>				
Value of large purchases in the last year (in USD)	13.3	-1.3	-39.9	-64.6

Value of all purchases in last 2 weeks (in USD)	0.2	0.2	0.5	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 quality of education outcomes such as homework hours and investment in school fees.

**School Attendance:** We find negative impact on school attendance. However, baseline school attendance rates were already high at over 90% for both 1AF and non1AF families, 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 comparison households. In Year 2, the impact on average hours of homework was 0.14 hours, and in Year 3 of the study this was 0.16 hours for children between 5 to 18 years of age. This might also be a result of increase in ownership of solar lights for 1AF 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 1AF households in Year 3. There was an increase in the average school costs for 1AF children under 6 by \$10.8 and children in secondary school by \$55.7.

Education Outcomes - Difference in Change Over Time for 1AF vs non1AF 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>	-3.1%
% of children attending private school	1.7%	-1.8%	2.3%
% of school-going children who are girls	6.1%**	3.4%	4.7%
% of those between 5 and 18 who are attending school	-1.4%	<b>-3.1%***</b>	-1.1%
% of those over 13 who are attending school	-3.4%	-3.80%	-7.5%
% of school-going children over 13 who are girls	1.4%	7%	5.6%
% of children 3- 6 attending school	-3.4%	2.04%	-19%
<b>Homework</b>			
Ave hours of homework last school night	0.1	<b>0.14**</b>	0.04
Ave. hours of homework last night if child is between 5 and 18	0	0	<b>0.16**</b>
<b>School fees paid</b>			
Ave School costs (outliers winsorize at 2*std. dev)	31.7	<b>8.6**</b>	3.9
School fees paid for under 6 children			<b>10.8**</b>
School fees paid for children in secondary school			<b>55.7**</b>

School Days Missed			
% who says days missed for lack of school fees	-2.6%	0.5%	2.1%
*** 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 1AF and non1AF 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 a reduction in moderate malnourishment for children in 1AF households by 20.6% pts. We find no significant impact on any of the remaining indicators of child nutrition being measured, which does not support the findings of decreased malnourishment rates. Strangely, in the first year of study in Kenya, we saw a negative impact on malnourishment rates for children in 1AF households. At that time, we had considered this finding anomalous as it was highly unlikely that 1AF could have made any impact on child nutritional status in only one year. However, we did not find corroborating increases in malnutrition for 1AF children using alternative measures such as MUAC, and we had results showing decreased hunger as well as higher dietary diversity for children in 1AF households. It is highly likely that both, the positive impact on nutrition outcomes in Year 3, as well as the negative outcomes in Year 1 are a statistical anomaly.

**Financial Literacy:** In Year 1, we found that 1AF 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 1AF farmers need to plan wisely to make program repayments on time.

Surprisingly, 1AF farmers were more likely to prefer planting only one crop over multiple crops than non1AF farmers by 22 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 1AF 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 1AF farmers in Kenya.

**Well-Being:** A steady finding from most years of the study is that 1AF farmers improve their mental well being due to program participation. After three years, 1AF farmers reported lower stress of 1.2 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.

**Women Empowerment:** The 1AF 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 1AF vs non1AF 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	-0.53
<b>Health</b>			
% of households reporting an illness in last 2 weeks	4.8%	0.9%	11.4%
% of those who sought treatment who saw a doctor or nurse	-5.6%	-1.5%	-13.7%
Ave health costs (outliers winsorized at 2*std. dev)	11.1	3.2	-4.1
<b>Well Being</b>			
Total Stress Score (higher score=more stress)	-0.8***	-1.2***	-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**	-0.15
<b>Child Nutrition</b>			
% malnourished (weight for age at < - 2 sd of WHO median)	8.6%**	-2.1%	4.4%
% moderately malnourished (weight for age at < - 2 sd of WHO median)	0.5%	11.8%	-20.6%**
% of children stunted (height for age at < - 2 sd of WHO median)	-2.1%	9.0%	-7.7%
% of children wasted (weight for height at < - 2 sd of WHO median)	-3.3%	-9.70%	7.8%

## Learnings and Recommendations for Programmatic Focus

Overall, this study has helped us gain invaluable insights on our program impact as well as provided a deeper understanding of farmers and their priorities. It largely confirmed our existing impact areas of improved farm yields, farm profits, and land cultivated. We were also able to rigorously test new impact areas that we had only hypothesized before the study such as improving asset ownership, consumption during harvest season, and farmer well being. At the same time, the study did not demonstrate impact in areas we where we thought we might see some improvements but were not certain; for instance, diet diversity, health, crop diversity, and income diversity. We are also more aware that decreased hunger does not immediately lead to better nutrition outcomes and dietary diversity. The study was incredibly valuable in encouraging 1AF to increase investments in these areas and we have made several programmatic changes to our program and these are listed below. Since this study began, the 1AF network has grown from 305,000 to 809,000 farm families. As a result of the increased scale of the program, these new interventions are now benefiting significantly more smallholder farmers and more than 3 million children that are part of these households.



**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 1AF. 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 1AF 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. 1AF 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). 1AF can explore how to continue supporting farmers as they move to higher degrees of agricultural investment through participation in the 1AF program. Currently, 1AF 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 1AF 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 in

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. 1AF already has made some progress in this regard. For example, 1AF 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 cook stoves.

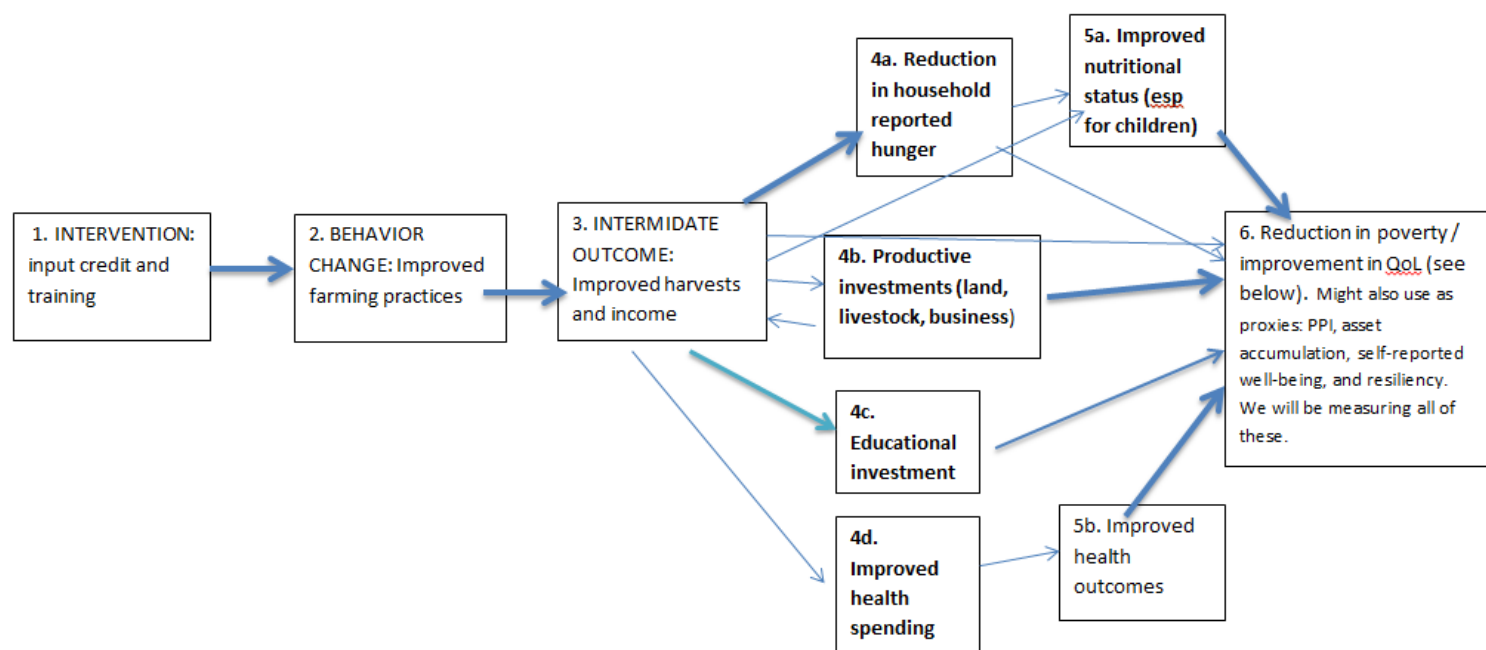
One Acre Fund's core program in Kenya is spread across the Western and Nyanza provinces which represent different agro-economic conditions. Here, altitude can range between 1,227 and 1,914 meters with annual rainfall ranging between 1,028 and 2,112 mm. Farmers enrolled in the Kenya program usually plant 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 1AF 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 1AF 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. 1AF also has partnered with the government to improve extension services in the country, which are intended to reach every single village. 1AF 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 non-1AF 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 1AF'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 a 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 comparison 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 1AF and non 1AF farmers we have regularly measured an 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 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 in 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 comparison 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 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 (comparison farmers 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 comparison farmers***

After the first year, 116 comparison farmers (out of a total of 1200 of them), crossed over the program border to enroll in the 1AF program. While these “contaminated” farmers would not have seen the benefits of the 1AF 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 comparison 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 1AF 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 comparison 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 for 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 comparison farmers based on characteristics to make them as comparable to 1AF farmers as is possible. DD might be problematic if only one group has been affected by an event (eg. violation of parallel trends assumption).

Propensity Score Matching: We have also used Propensity Score Matching as a control refinement technique to smooth out differences between treatment and comparison 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>8</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>9</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.

Multiple Hypothesis Issues: We will be testing numerous hypotheses to understand the impact of the 1AF 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.

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<sup>8</sup> See “Assessing the Reliability of Household Expenditure Data: Results of the World Health Survey” World Health Organization. Discussion Paper #5, 2007

<sup>9</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).



## ANNEX E. ANOMALOUS HUNGER OUTCOMES

Food Security - Difference in Change Over Time for 1AF vs non1AF 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>31.7%***</b>
Total amount of maize harvest remaining (kg)	<b>12.21**</b>	19.8*	<b>-13.33***</b>	19.3*
Dietary Diversity (higher score indicates a more diverse diet)	<b>0.312**</b>	-3.60%	-0.111	0.04
<i>For the outcomes below a negative number indicates a positive program effect</i>				
Percent reporting "severe hunger season" (reported they almost never had enough to eat)	-3.5%*	-3.0%	4.70%	2.5%
Months of reported hunger season	<b>-0.562***</b>	<b>-0.39**</b>	0.343	-0.24
Fanta score (higher score indicates greater hunger)	<b>-0.593***</b>	-0.08	<b>0.620***</b>	0.12
% who had no food to eat because of lack of resources (in past 30 days)	<b>-35.9%***</b>	3.80%	<b>45.6%***</b>	<b>11%**</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%*	-4.6%
% of HH where a member went 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>4.8%**</b>
*** p<0.01, ** p<0.05, * p<0.1				