

ONE ACRE FUND

Optimizing Maize Variety Adoption and Performance *2015 Trial Report*



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INTRODUCTION

There are currently 279 varieties of maize seed legally released in Kenya, with 37 new additional varieties released in 2015 alone. The Kenya Agriculture and Livestock Research Organization (KALRO), along with numerous national and international seed companies, have developed a robust pipeline of new varieties that are released each year. Newly released varieties are intended to impart yield advantages and have greater resilience to biotic (pest and disease) and abiotic stress (drought, heat, soil fertility) relative to older seeds. However, farmers are often slow to adopt these newly released varieties. Weighted for farmer preference, the average age of varieties distributed by One Acre Fund in 2015 was 14 years. In contrast, the average life span of a hybrid maize variety in the United States is between 3 and 5 years.

During the 2015 long rains season in Kenya, One Acre Fund sought to better understand maize variety performance and the critical drivers of farmer variety selection and retention. We evaluated 16 varieties focusing on two different types of actions that One Acre Fund could simultaneously take with respect to maize variety selection:

1. Greater focus on variety recommendations: One Acre Fund can invest more heavily in providing farmers with information and guidance in the variety selection process among all varieties we currently sell.
2. Greater focus on introducing newly released varieties: One Acre Fund can invest more heavily in the inclusion of newly released varieties in our seed catalogue, and the marketing of these varieties.

With these two different action points, One Acre Fund distributed two small packs of maize seed to over 5,000 farmers. The first pack was a variety already offered by One Acre Fund that we believed, based on available data, to be a top-yielding variety for that area. The second pack was a variety not currently offered by One Acre Fund that we believed, based on available data, to be a top-yielding variety for that area. The primary objective of this trial was to evaluate the relative performance of different varieties in different environments to inform organizational decisions about varietal sales and recommendation optimization.

Highlights of our findings are as follows:

- The average maize variety purchased by a One Acre Fund farmer in 2015 was 14 years old. In the last 14 years 233 new varieties of maize have been released in Kenya.
- The average farmer could achieve a 2 percent to 13 percent yield increase by switching from their current variety to the most appropriate new maize variety.
- About 30 percent of farmers could achieve an 8 percent to 15 percent yield increase by switching from their current variety to a more suitable variety already offered by One Acre Fund.

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- Group leaders growing new variety demonstration plots were more than 2.5x more likely to purchase that new variety in the following season than group leaders in the same district who did not grow that demonstration plot. The same holds true for group members whose group leader grew demonstration plots.
- While many factors matter to farmers when selecting maize varieties, yield, maturity period, and disease resistance are the factors most frequently cited by farmers (>24 percent), followed by familiarity, taste, and consistency (>10 percent).
- Factors including appearance, cost, and ease of storage were infrequently cited as important to the variety selection processes (<5 percent).

ONE ACRE FUND MAIZE VARIETY MARKETING AND ADOPTION

Toward the end of 2014, One Acre Fund field officers enrolled over 137,000 farmers in Kenya to participate in the One Acre Fund Program during the 2015 long rains. The vast majority of these farmers selected a maize variety during this enrollment period. The seed catalogue (pictured to the right) is a key tool to help facilitate seed selection; it includes information about maturity periods and disease resistance. Along with this catalogue, for the past few years we have provided district-specific maize variety recommendations. This supplemental guide helps farmers prioritize varietal selection across our agroecologically diverse operating landscape.



Figure 1: One Acre Fund 2015 maize seed catalogue.

Table 1. One Acre Fund maize varieties, varietal age and farmer adoption. Kenya, 2015.

Variety	Year of Release (years old)	% Adoption
Kenya Seed H 6213	2002 (13)	21%
Monsanto DK 8031	2003 (12)	20%
Kenya Seed H 614D	1986 (29)	17%
Western Seed WH 507	2010 (5)	13%
Seed Co SC Duma 43	2004 (11)	10%
Various WE 1101	2013 (2)	6%
Pannar PAN 691	2001 (14)	4%
Pannar PAN 67	2001 (14)	4%
Kenya Seed DH 04	2001 (14)	3%
Seed Co SC Punda Milia 53	2005 (10)	2%
Pannar PAN 4M-21	2005 (10)	<1%

We consider newer varieties on an annual basis to add to the seed catalogue, and attempt to update our recommendations to reflect new information and evolving programmatic boundaries. However, we had not systematically evaluated the economic value of introducing new varieties to the catalogue and increasing compliance with our district recommendations.

TRIAL OVERVIEW

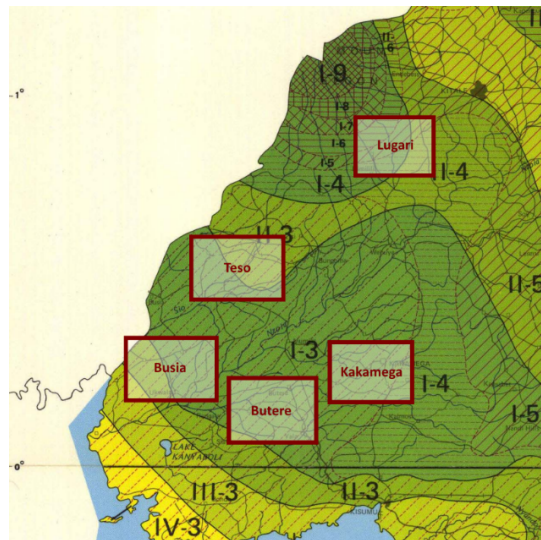
Hypotheses

This trial was designed with the intention of testing four hypotheses:

1. Newer varieties have higher yields than the older varieties One Acre Fund is currently offering (and that program farmers are growing) within each maturity category. Introduction and adoption of these varieties into the program will result in significant yield gains for program farmers.
2. Farmers may not be selecting the optimum variety currently offered for their region. Switching to the ideal maize variety currently offered will result in significant yield increases.
3. Greater exposure to a new variety of maize seed as a demonstration plot will result in higher purchase rates of that new variety.
4. Maize variety yield is the most important driver of stated farmer preference and purchase rates for that variety.

Design

In 2015, One Acre Fund worked with over 137,000 farmers across 20 districts in western Kenya. These farmers were members of over 17,000 groups, each having a volunteer group leader. We selected five of these districts that collectively represent the agroecological diversity of One Acre Fund operating areas and distributed small seed and fertilizer packs to each group leader within these five districts, totaling over 5,000 group leaders.



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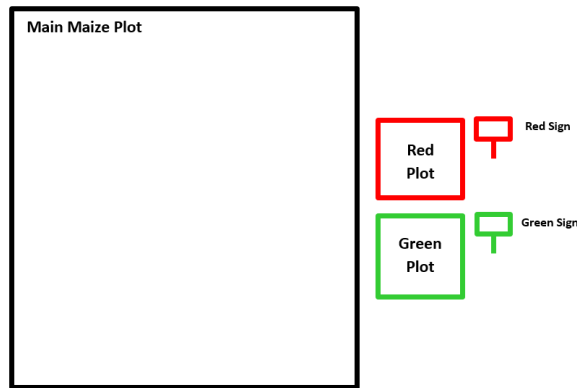
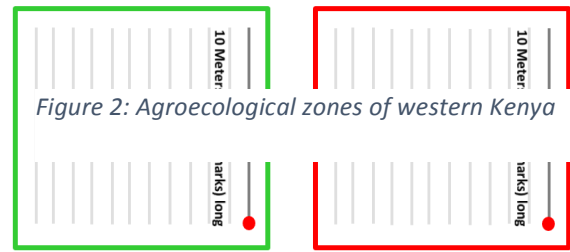


Figure 3: Trial plot arrangements on-farm



Make sure that:

1. You only use green inputs for the green plot and red inputs for the red plot.
2. Each plot is one big step from the other and one big step from your main maize plot.
3. Each plot has 12 rows.
4. Each row is 10 meters long (two red marks on the planting string).
5. Each plot has a sign in front of it.

Figure 4: Trial plot planting instructions

Each group leader participating in the trial received two 250 gram packs of seed, each sufficient for growing a 10x10 meter plot. One pack contained a variety of maize seed that One Acre Fund already sold and, based on historical data, was a top-yielding variety for that area. The other pack contained a variety of maize seed that One Acre Fund did not sell, but was recently released in Kenya and available data suggested was one of the top-yielding varieties available in Kenya. Farmers were provided fertilizer and planting instructions, partially facilitated by visual reference guides (below).

Throughout the course of the season, we collected self-reported preference data. At the end of the season we conducted a more in-depth farmer preference survey, paired with yield measurements of the two distributed varieties. We also took a yield measurement from the group leader’s main maize plot as a reference point. The trial included the following districts and maize varieties:

Table 2. Seed selection and trial design for the 2015 long rains in western Kenya.

District	Maturity Category	One Acre Fund Varieties (red)	Non-One Acre Fund Varieties (green)	# Farmers
Busia	Early / Medium	Kenya Seed DH 04 Seed Co SC Duma 43 Monsanto DK 8031	Seed Co SC PM 529 Pioneer P2859W	1,251
Teso	Medium	Western Seed WH 507 Pannar PAN 67 AATF WE 1101	Seed Co SC Simba 61 Monsanto DKC 90-89 Pioneer P3812W	967
Butere	Medium	Western Seed WH 507 Pannar PAN 67 AATF WE 1101	Seed Co SC Simba 61 Monsanto DKC 90-89 Pioneer P3812W	818
Kakamega	Medium / Late	Kenya Seed H 614D Kenya Seed H 6213	Kenya Seed H 6218 Seed Co SC Tembo 73 Monsanto KH 600-22A	1,210
Lugari	Late	Kenya Seed H 614D Kenya Seed H 6213	Kenya Seed H 6218 Seed Co SC Tembo 73	1,173

				Monsanto KH 600-22A
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Due to operational constraints, we were not able to distribute seed packs to some group leaders within a particular district. This limited our ability to infer correlations between the presence of demonstration plots and adoption of a demonstration plot variety in the following season.

Additionally, we were unable to randomize variety distribution at the group leader level. Instead, we randomized at the “site” level, of which there are between 30 and 50 per district. Each site received a randomized pairing of “red” (program variety) and “green” (non-program variety) seed packs appropriate for the district agroecology.

TRIAL RESULTS

Hypothesis #1: Newer varieties have higher yields than the older varieties One Acre Fund is currently offering (and that program farmers are growing) within each maturity category. Introduction and adoption of these varieties into the program will result in significant yield gains for program farmers.

Results: The structure of Kenyan National Performance Trials (NPT) requires that newly released varieties must out-perform “commercial checks” in the same maturity category. Theoretically, this implies the new varieties have a higher yield potential than the older varieties. The average age of non-program commercial varieties used in the trial was 6 years while the average age of high-performing program varieties used in the trial was 12 years. The average yield of non-program commercial varieties used in the trial was 5.0 t/ha while the average yield of high-performing program varieties was 4.84 t/ha. However, the economic significance of a 3 percent yield increase may not be sufficient to justify mass adoption of new commercial varieties.

We also saw that the magnitude of this difference varied from district to district, hitting a maximum of 7.1 percent in Butere. In Kakamega there was no difference, and in no district was the difference statistically significant. The best impact return on investment organizationally may be to target introduction and elimination of specific varieties in specific areas. For example, replacement of Kenya Seed H

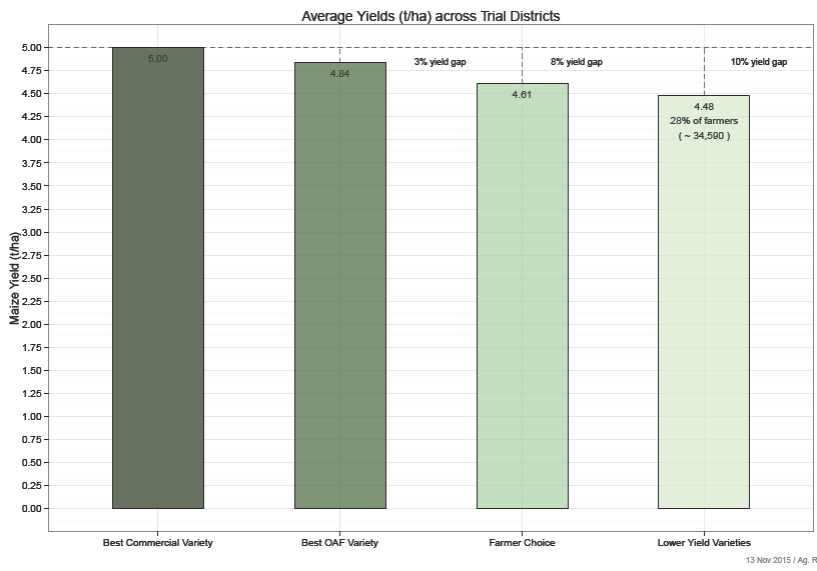


Figure 5. Comparative yields between selected trial and programmatic hybrid maize varieties.

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6213 with H 6218 may mean an 8.5 percent yield increase for the estimated 40,000+ One Acre Fund farmers who will grow H 6213 in 2016.

Table 3. Comparative yield means between optimum commercial and programmatic hybrid maize varieties along multiple districts in western Kenya, long rains 2015.

District	Commercial (t/ha)	Program (t/ha)	Difference (t/ha)	Difference (%)
Busia	4.19	4.00	0.19	4.8%
Teso	4.37	4.24	0.13	3.1%
Butere	5.29	4.94	0.35	7.1%
Kakamega	5.37	5.41	-0.04	-0.7%
Lugari	5.67	5.57	0.10	1.8%
Total	5.00	4.84	0.16	3.3%

Introducing new varieties can be a valuable method for increasing farmer yields. However, the yield impact of new varieties is contingent on farmer adoption. During enrollment for the 2016 long rains season, 9 percent of clients purchased one of the four newly introduced varieties. Continued work must be done to understand the adoption drivers of new varieties.

Hypothesis #2: Farmers may not be selecting the optimum variety currently offered for their region. Switching to the ideal maize variety currently offered will result in significant yield increases.

Results: In 2015 One Acre Fund sold 11 different maize varieties in Kenya. Each of these varieties was appropriate for a particular agroecology, but not necessarily for others. However, varieties are soil irrespective of agroecozone. The result is that many farmers have chosen to grow varieties that may not be the optimal choice for their geography. We observed that, among these farmers, an 8 percent to 15 percent yield increased may be realized by switching the seed they grow to a more agroecologically appropriate variety.

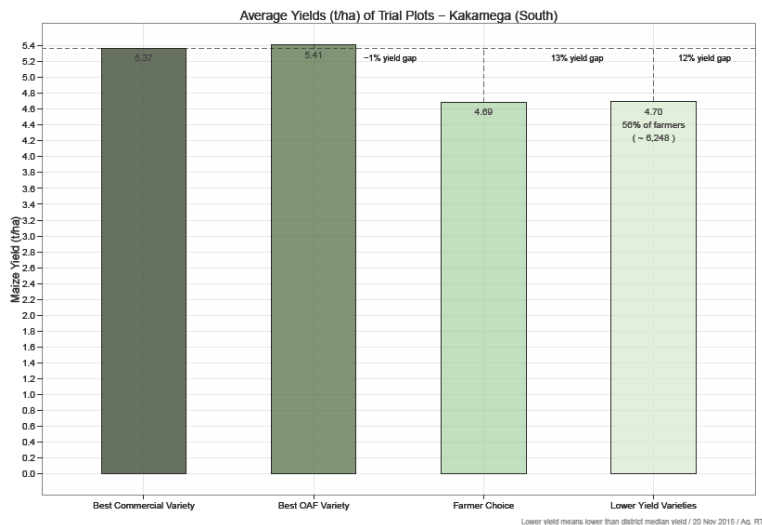


Figure 6. Comparative mean yields of hybrid maize varieties within the high-productivity agroecological zone in western Kenya.

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The scale magnitude of this effect is dependent on the district and the percent of farmers in that district growing an appropriate or inappropriate variety. For example, in Kakamega the majority of farmers (56 percent) are growing a sub-optimal variety and a 15 percent yield increase could be achievable simply by switching to a variety that we already offer and are likely somewhat familiar. Alternatively, in Teso a small minority of farmers are growing inappropriate varieties, but even fewer farmers are growing the highest-yielding variety. This suggests that adoption dynamics have a geospatially explicit component and a one-size-fits-all approach may not be appropriate.

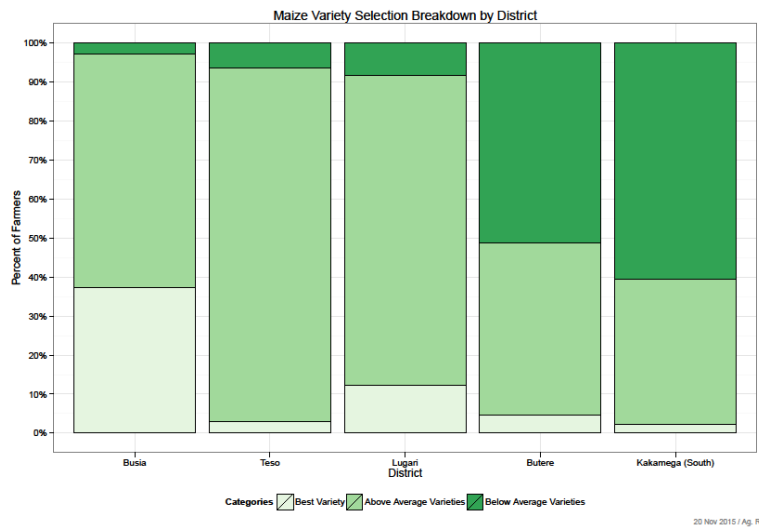


Figure 7. Adoption of variety type along five different agroecologies of western Kenya, long rains 2015.

Table 4. Yield difference between selection of optimal and sub-optimal hybrid maize varieties between five districts in western Kenya, long rains 2015.

District	Optimal (t/ha)	Sub-Optimal (t/ha)	Difference (t/ha)	Difference (%)	# Sub-Optimal
Busia	4.00	3.51	0.49	14.0%	1,594 (14%)
Teso	4.24	3.92	0.32	8.2%	1,252 (14%)
Butere	4.94	4.54	0.40	8.8%	3,454 (44%)
Kakamega	5.41	4.70	0.71	15.1%	6,248 (56%)
Lugari	5.57	4.98	0.59	11.8%	2,312 (20%)
Total	4.84	4.48	0.36	8.0%	14,860 (29%)

Hypothesis #3: Greater exposure to a new variety of maize seed as a demonstration plot will result in higher purchase rates of that new variety.

Results: Group leaders who grew demonstration plots during the 2015 long rains were about 2.5 times as likely to purchase that variety during the 2016 long rains as were group leaders in that same district who did not grow the variety as a demonstration plot. Similarly, farmers who did not grow demonstration plots themselves, but whose group leaders grew demonstration plots were about 2.5 times as likely to purchase that variety during the 2016 long rains as were non-demonstration plot farmers in the same district.

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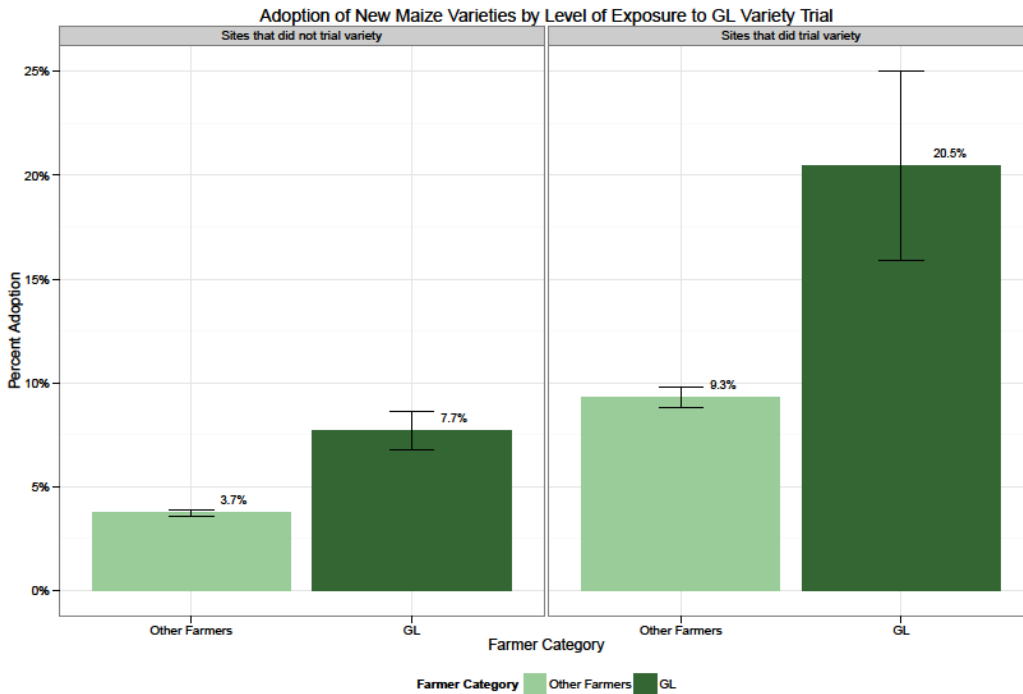


Figure 8. Adoption of new maize varieties with farmer groups who were exposed to demonstration plots (GL – group leaders) and groups who were not (other farmers). Western Kenya, long rains 2015.

We found that group leaders are more likely to try a new variety than non-group leaders. On average, regardless of whether or not a group had increased exposure to demonstration plots or not, group leaders were about twice as likely to try a new variety as farmers who are not group leaders.

This suggests that group leaders may be more willing to participate in programs to distribute and market new maize varieties and that the presence of new varieties in these areas – even if not on every farm – can have a spillover effect on adoption of that variety. It may be possible to vary the intensity of exposure even further in this model, asking group leaders to invite their group members to their farm to see the varieties, or even asking them to participate in harvest so that group members have first physical exposure to the increased yields. Ultimately, it is likely that group leaders will still have higher new variety adoption rates than group members as group leaders are selected due to their perceived leadership abilities and may have greater levels of education than their fellow group members. However, the difference in adoption rates may be narrowed through different forms of group engagement with demonstration plots.

Future trials will likely focus more heavily on the strategies that One Acre Fund can employ at scale to increase farmer awareness of and confidence with new variety options.

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Hypothesis #4: Maize variety yield is the most important driver of stated farmer preference and purchase rates for that variety.

Results: A number of factors play in to a farmer’s decision to purchase a particular variety of maize seed. However, the factor most frequently cited by farmers was yield (43 percent). Disease resistance and maturity period were also frequently cited at 26 percent and 24 percent, respectively. Appearance, cost, and ease of storage were not frequently cited, all <5 percent. However, the relative importance of individual factors did vary from district to district. For example, maturity period was cited as important by 17 percent of farmers in Lugari, where the season is fairly long and therefore less of a constraint and by 32 percent of farmers in Butere where the season length is more of a constraint.

Table 5. Prominent drivers of adoption for farmers surveyed in western Kenya, long rains 2015.

Factor	% of Farmers Citing a Factor as Important					
	Busia	Butere	Kakamega	Lugari	Teso	Total
Yield	44%	40%	45%	41%	46%	43%
Disease Resistance	25%	27%	27%	27%	27%	26%
Maturity Period	28%	32%	23%	17%	30%	24%
Familiarity	13%	12%	9%	10%	16%	12%
Taste	10%	16%	12%	8%	16%	11%
Consistency	9%	13%	8%	11%	11%	10%
Appearance	4%	5%	5%	4%	10%	5%
Cost	5%	3%	4%	1%	4%	3%
Flour Quality	4%	6%	1%	0%	5%	3%
Ease of Storage	3%	5%	1%	0%	6%	2%
Ease of Milling	1%	3%	0%	1%	3%	2%
Ease of Sale	1%	1%	0%	0%	1%	0%

While yield is the most frequently cited factor in all districts that did not necessarily translate in to stated preference for the highest yielding varieties. For example, in Kakamega the two lowest-yielding varieties – SC Tembo 73 and H 6213 – were also the most preferred varieties while the highest yielding variety – H 6218 – was the second least preferred variety of the five. This suggests that while yield was the factor most frequently cited as

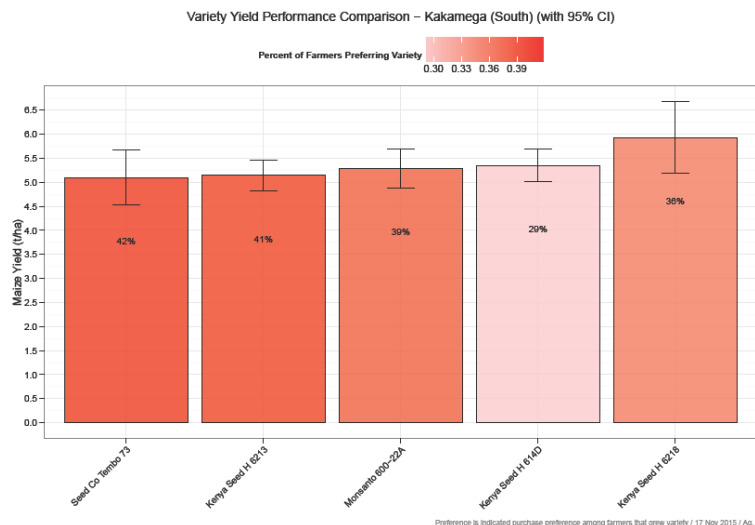


Figure 9. Yield performance among farmer hybrid maize variety preferences in Kakamega, Kenya. Long rains, 2015.

important, the intensity of this importance relative to other factors may vary.

NEXT STEPS

This trial was designed with the following actions in mind:

Adding new varieties to the maize seed catalogue

During enrollment for the 2016 long rains season we offered four new high performing varieties and removed two low performing varieties based on data collected as part of the trial. Data was incomplete at the time of enrollment so we will likely make further changes to the 2017 offering.

Our goal in updating the seed catalogue to include newer varieties is to ultimately provide farmers with the highest-yielding options that fit their preference criteria. It is unlikely that we can make substantial updates to the catalogue each season. Introduction of new varieties takes time, and while dozens of new varieties can be released each year, only some will ultimately be commercialized at a large scale by seed companies we work with.



Figure 10: One Acre Fund 2016 maize seed catalogue

Updating of the district-level maize variety recommendations

The five districts included in this trial are collectively representative of the areas in which we operate. By extrapolating outcomes from these districts to those with similar growing conditions we were able to update our district-level recommendations for the 2016 long rains season. We will continue to use the complete data to further refine these recommendations for the 2017 long rains season.

Launching more work in understanding maize variety adoption

This trial was primarily concerned with defining the magnitude and variability of yields resulting from different maize seed selection decisions. While we were able to observe positive adoption effects associated with demonstration plots and are in the process of better understanding the effects of different demographic factors on seed decision making processes, this trial itself was not primarily concerned with understanding farmer adoption dynamics of new maize varieties.

With the number of new varieties being released each year, to more regularly update our offering and get the best possible seed in to the hands of Kenyan smallholder farmers we must become more proficient in marketing new seed. In 2016 we will continue this work, focusing more substantially on understanding what actions we can take, at scale, to increase farmer adoption of new, improved varieties.