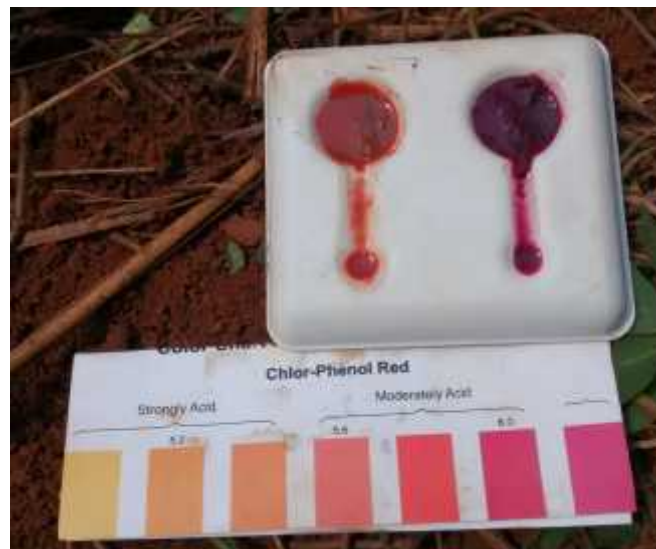


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PHASE:	(1) Research Station	(2) 50 – 500 farmers	(3) 500 – 20,000 farmers	(4) Full Scale
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Introduction

One Acre Fund Rwanda has sold agricultural lime/travertine since its founding, but until 2016 average adoption of this product was only 1-3% per season. This was despite the fact that most soils in Rwanda are highly acidic, ranging from 4.5-6 on average, and the product has shown high impact in side-by-side trials. In a trial in Nyamasheke district from 2011B-2013B, applying 25 kg/are of lime one time at the beginning of the period increased maize yields by 25% and bean yields by 75% for each of the next 5 seasons.



Because of the high impact and low adoption combination, both the Government of Rwanda and One Acre Fund took a number of initiatives to boost adoption of liming materials in 2016. These initiatives included a farmer price subsidy, a bonus for Field Officers who sell more lime, soil pH testing of farmer fields, and free samples.

One Acre Fund also undertook a large survey in February, 2015 to ask farmers questions about their lime and travertine knowledge, past experience, and reasons for adoption and non-adoption. Our goal was to analyze this survey as well as the results of our different initiatives on travertine and lime adoption to determine what the most effective mechanisms are for driving up adoption of this important product.

10.8 Kg/client increase in lime purchased by clients given a soil pH test

268% SROI for the pH test kits

61% Percent of non-adopting farmers who did not adopt lime because they do not believe their soil is acidic

16-20% Lime adoption rates in subsidy districts

Objectives

-) Determine the relative importance of several different factors on lime/travertine adoption, including: land ownership, past experience with the product, reported knowledge of the product, experience with One Acre Fund (years as a client, Group Leader status, exposure to marketing in 16B), living in higher-altitude (generally more acidic) district, living in a government subsidy district, receiving a soil pH test, and participating in one of One Acre Fund’s free gift trials.
-) Calculate the cost versus benefit of some of the promotion initiatives attempted by One Acre Fund
-) Generate recommendations on how to continue lime/travertine promotion in the future.

Hypotheses

-) Adoption will be significantly higher in subsidy districts than in non-subsidy districts
 - o Part of this will be due to the fact that those districts tend to be more acidic
 - o Another part will be due to the lower price

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- We will attempt to distinguish these effects by looking at the comparison between acidic, non-subsidy districts (Ngororero, Giheke, Rutsiro) and acidic, subsidy districts
-) Adoption will be higher in 2017A in the sites that received free travertine or lime in 2016B, because farmers will have observed the positive effect first-hand
 - It may be higher in sites with the 5 kg trial than those with the 50 kg trial, because many farmers who received 50 kg in 2016B might see it as unnecessary to get more lime after only one season
-) Adoption in 2016B will be higher for farmers who received soil pH tests in 2016B, and adoption in 2017A will be higher for farmers who received soil pH tests either in 2016B or 2017A
-) Even when controlling for other demographic factors these trials will have a positive, significant effect on adoption, but some demographic factors are also likely to affect adoption, especially land ownership

Methodology

Prior to 2016B, One Acre Fund generally sold calcitic lime as its liming product. The price was 130 FRw/kg during the 2016A season. At the time of marketing, lime was listed as one product of many on the “fertilizer” catalog and was not given special focus. No monetary incentive was offered to Field Officers to sell more lime. Lime had always been sold in units of 25 kg minimum.

During the 2016B season the following changes were made:

-) **Government subsidy:**
 - This applied in select districts: Nyamagabe, Nyaruguru, parts of Rubengera, Karongi, Nyamasheke, Mugonero, Kibogora
 - The government selected travertine—unburned lime—as the product for subsidization, because it is less expensive and produced with less damage to the environment.
 - Trials had already confirmed that these lime and travertine products produced the same level of impact, statistically, so One Acre Fund was happy to move toward a replacement of lime with travertine
 - The subsidy dropped the price of travertine to 25-30 FRw/kg
-) **Lime sales in other districts:**
 - One Acre Fund continued to sell lime in other, non-subsidy districts, since we still had this material in stock
 - The price was dropped from 130 FRw/kg to 100 FRw/kg
-) **Marketing emphasis:** FOs were given a catalog that included a separate page highlighting the problems of acidity and the importance of lime/travertine
-) **Field Officer Bonus:** Field Officers were promised a monetary bonus of 5 FRw for every kg of lime/travertine that they sold to clients (it had to be not only ordered, but actually picked up)
-) **Soil pH testing trial:**
 - Field Officers in Kibogora and Nyamasheke districts received pH testing kits (produced by Cornell University) and were supposed to test the soil of as many clients as possible during the enrollment period, to show them the pH level of their soil and convince them to buy travertine
-) **Cell-level promotional trials:**
 - In 3 sites each in 5 districts, special trials were run
 - The 3 treatments in the trial were:
 - The option of 5 kg units of lime/travertine instead of a minimum 25 kg units
 - 5 kg lime/travertine given free to all farmers, automatically (no need to sign up)
 - Up to 50 kg lime/travertine given for free to farmers who signed up (not automatic)
 - The goal was both to observe how the trials affected quantities of non-free lime/travertine taken in 16B, and also (and more importantly) to measure the effect of this trial on future adoption, in 17A.

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) **Lime adoption + knowledge survey:**

- In January and February 2016, during and after inputs distribution, clients were surveyed to learn about their knowledge and attitudes toward lime, sources of information, demographics, and stated reasons for adoption or non-adoption.
- The survey covered over 3,200 TUBURA clients across 18 districts.
- These data were then linked with 16A and 16B lime/travertine orders, and regression analysis was conducted on the correlates of lime/travertine adoption.

In 2017A:

) **Only travertine sold:** One Acre Fund made the decision to transition to travertine as our only liming material for sale, to be aligned with the government.) **Subsidy:**

- At the time of marketing and contract signing, the government had not yet announced the districts that would be in the subsidy program.
- One Acre Fund marketed the travertine as “Maximum 100 FRw/kg, or government subsidy price if the subsidy is run again”
- In the end, the government ran the travertine subsidy in the same districts as 2016B, plus some additional districts—Huye, Gisagara, Giheke, Rusizi, and Bugarama.
- One Acre Fund was not able to participate in the subsidy program in the end, so we canceled the travertine orders for clients in those districts prior to distribution. The farmers were still able to get travertine through their sector offices instead of from One Acre Fund.
- For the purposes of 2017A adoption analysis we will look at order data prior to dropping the subsidy districts.

) **Marketing emphasis and FO bonus:** These initiatives continued as in 16B.) **Cell-level promotional trials:** These were not repeated in 2017A, but we did examine the correlation between the 2016B trials and the 2017A travertine orders in those sites.) **Soil pH testing trial:**

- We extended this trial include all 11 of the highest altitude, most acidic districts in the One Acre Fund program—Rutsiro, Ngororero, Karongi, Rubengera, Mugonero, Kibogora, Nyamasheke, Rusizi, Giheke, Nyaruguru and Nyamagabe
- Every FO received a pH kit as in the 16B trial, though this time they were to return the empty kit at the end for verification of the level of chemical used and so that the box and chemical bottles could be re-filled and re-used in the future.
- Kits and training were given in April 2016, a month before marketing and enrollment began, at the same time as training on soil fertility and compost. The goal was to give extra time to the FOs to reach more clients with the pH testing before they started enrollment meetings.
- At data entry and cleaning time we, unfortunately, realized that much of these data were untrustworthy, because the FOs reported testing far more farmer fields than would have been physically possible given the amount of liquid that they had used up (this was verified using re-collected kits).
- Because of this, we chose to narrow the analysis only to sites for which the numbers sounded reasonable and trustworthy, and the same size was small.

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Results:

One Acre Fund Adoption Data Based on Orders

District	% Travertine/lime adoption			Travertine/lime kg/client		
	16A	16B	17A	16A	16B	17A
16B Lime Districts	2%	7%	9%	0.7	2.2	5.0
16B Travertine Districts	3%	21%	16%	1.2	13.1	17.7
Grand Total	3%	13%	12%	0.9	7	10.2

-) There was a substantial increase in % adoption from 2016A to 2016B that generally stayed high, but did not increase further in 2017A.
-) A much larger increase in adoption occurred in the subsidy districts (from 2% to 16-20%), versus the non-subsidy districts (2% to 7-9%)
-) Overall, kg/client ordered increased quite substantially from 2016A to 2016B, then again (and even more dramatically) from 2016B to 2017A.

Lime Adoption Survey Results- Reported Reasons for Non-Adoption:

Reported Reasons for non-adoption				Used lime in past		Land size owned (ares)		Does not know benefit of lime		Learned about lime from FO	
Don't need lime	Don't know importance of lime	Lack of money	Other	16B Adopter	16B non-adopter	16B Adopter	16B non-adopter	16B Adopter	16B non-adopter	16B Adopter	16B non-adopter
61%	27%	33%	13%	26%	14%	38	46	5%	13%	85%	75%

-) By far the biggest reason (61%) for non-adoption is the perception among farmers that their soil is not acidic and therefore they do not need lime (this is why we think the pH test is a good intervention, because in most cases it proves that lime is, in fact, needed)
-) The second two big reasons for no adopting lime are lack of money (33%) and lack of knowledge about the importance of lime (27%), though in a few districts these are more important than the averages show.
-) Farmers who bought lime in 2016B were slightly more likely to be One Acre Fund group leaders, to have learned about lime from their FO, to have used lime in the past, to have smaller land size, and to have higher knowledge about lime (benefits, how to use it, effect of acidity on plants).
-) For more summary statistics, refer to the Appendix

2016B Regression Analysis

Factors found to significantly affect demand for lime or travertine were:

-) The factor with the largest effect on quantity of travertine ordered, by far, was being in one of the subsidy districts. This was likely partially due to the high acidity in those districts, but mostly due to the low price and government promotion.
-) Being in the subsidy district also increased the likelihood of adoption, though it was only the third most important factor.
-) Use of lime in the past (both for likelihood of adoption and quantity)
-) Being in the cell with the 50 kg lime trial (both for likelihood of adoption and quantity)
-) Receiving the pH test (for likelihood of adoption and for quantity)
-) Attending more meetings during marketing (for quantity adopted, though no significant effect on likelihood of adoption)

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Factors that showed mixed or counter-intuitive significance included:

-) % land owned: the coefficient is negative, suggesting that owning more land led to a decrease in a farmer’s One Acre Fund lime order. This might be related to the fact that there is higher land ownership in the East where soil is less acidic, or because farmers who own more land might be wealthier and thus buy their lime from an agrodealer.
-) Number of years a farmer has known about lime: a negative relationship, suggesting that a farmer who has known about lime for longer is less likely to use it. Perhaps this reflects the fact that some farmers have heard about lime vaguely for a long time without really being shown its importance, and those people are the most skeptical of our new lime-push this season.
-) Farmer is aware of negative impact of acidity on soil: Compared to those who reported not knowing about lime, these farmers had much larger and statistically significant log-likelihood of adopting lime, but there was no link between this variable and quantity adopted.
-) High altitude district: This variable is significant in both regressions if travertine district is left out. However, in the likelihood of adoption regression it is significant even with travertine district included. This suggests that the districts of Giheke, Rusizi and Ngororero had higher adoption than other lime districts, but that the quantity adopted was not significantly different.
-) 5 kg unit trial: In terms of magnitude and controlling for all other factors, this variable actually had the largest magnitude effect on increasing log-likelihood of lime adoption. At the same time it had no significant impact on quantity adopted, but that is logical because it was designed to attract farmers who just wanted to try out a small amount of lime for the first time, and thus would have lower orders of around 5-10 kg. On the other hand, we can’t draw many conclusions from this data because the portion of the survey sample that came from these cells was very small.

Linear Regression on kg lime/travertine ordered in 2016B

Variable	Coefficient	P> t
Cell in 50 kg free trial	24.04	0.001
District Received Subsidized Travertine	14.88	0
Farmer used lime in past	13.85	0
Farmer got the soil pH test	8.74	0.043
% Land owned	-6.87	0.042
Number meetings attended during 16B marketing	0.58	0.028
Years farmer has known about lime	-0.41	0.016
Farmer says she doesn't know about lime	3.99	0.269
Farmer is aware of negative effects of acid on soil	5.96	0.11
Farmer is Group Leader	-1.23	0.54
High Altitude District	2.92	0.224
Cell in 5 kg free trial	-8.79	0.197
Cell in 5 kg unit trial	-2.91	0.544
Land cultivated (ares)	0.00	0.699

Logistic Regression on likelihood of lime/travertine adoption in 2016B

Variable	Odds Ratio	P> t
Cell in 5 kg unit trial	22.00	0
Cell in 50 kg free trial	16.52	0
High Altitude District	3.62	0

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Farmer got the soil pH test	2.34	0
Farmer is aware of negative effects of acid on soil	2.31	0.005
District Received Subsidized Travertine	1.75	0
Farmer used lime in past	1.57	0
Farmer is Group Leader	1.18	0.167
Land cultivated (ares)	1.00	0.671
% Land owned	1.09	0.707
Years farmer has known about lime	0.98	0.135
Farmer says she doesn't know about lime	0.73	0.262
Number meetings attended during 16B marketing	0.02	1.011
Cell in 5 kg free trial	0.94	0.881

2016B Season Free Sample Trials and 2017A Orders

16B Trial	Clients in sites	Average 17A Travertine Order (kg)					TOTAL
		Giheke	Gisagara	Karongi	Kibogora	Nyanza	
None	567	4.7 a	2.2 a	5.6 a	3.5 ac	0.7 a	3.8 a
5 kg free	967	4.7 a	1.0 a	7.1 a	6.3 bc	0.8 a	3.0 a
50 kg free	8,577	18.8 b	4.9 b	4.7 a	1.5 a	2.1 b	7.1 b

17A Travertine Adoption Rate						
16B Trial	Giheke	Gisagara	Karongi	Kibogora	Nyanza	TOTAL
None	13% a	6% a	7% a	6% a	2% a	7% a
5 kg free	11% a	3% a	17% b	7% a	2% a	7% a
50 kg free	73% b	13% b	9% a	2% b	5% b	24% b

Significant levels are based on the 90% threshold

We are only looking at farmers in the sectors that included the 16B trials

-) Sites with the 50 kg free travertine/lime trial did have substantially higher % adoption and kg/client in 2017A when compared to other sites in the same sectors in the three districts without the subsidy in 16B (Gisagara, Giheke and Nyanza).
-) On the other hand, the 50 kg free sites in the subsidy districts (Karongi and Kibogora) did not have higher % adoption of kg/client
 - o In fact, there were significantly lower orders in 17A in Kibogora for the 50 kg free sites when compared to the 5 kg free and control sites.
 - o In Karongi there was no significant difference in kg/client orders between all three treatments, but with regard to % adoption in 17A, the 5 kg free trial was substantially and significantly higher than control sites or sites with the 50 kg free trial in 16B.
-) This difference may be because so many farmers received 50 kg free and many also purchased additional quantities, and so in 2017A they felt that they did not need to buy any more travertine.
 - o This suggests that 5 kg might be a more appropriate free gift size to spur purchases in the following season.
 - o On the other hand, it might be that the farmers who got 50 kg free will see the effect from the lime that they already applied decline over time, and then will buy more in 17B, 18A or 18B. It would be worth checking the differences in adoption in these sites over the next 1-3 seasons to test whether the 50 kg bonus does spur future purchases of lime, just on a longer-term time frame.

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2017A Soil pH Testing

Client Exposure to test	Sample size	Average travertine ordered, kg/client	% travertine adoption
None at all	23,185	12.2 a	14% a
Observed (at meeting, neighbor's field)	4,590	36.4 c (+198%)	22% b (+57%)
Received test on own field	9,597	23.0 b (+89%)	21.6% b (+57%)

Cost vs. Benefits of Soil pH kits:

-) We analyzed data in the end from only 139 sites, where we confirmed that the data was “trustworthy” (liquid level used reasonably matched the reported number of tests).
-) FOs tested fields for about 22% of 2017A clients and demonstrated the pH test in meetings with an additional 13% of clients.
-) Farmers who did not have any exposure to the soil pH test ordered 12.2 kg of travertine on average compared to 23 kg who got the test in their own field and 36 kg who observed the test but not in their personal field.
 - o We expected adoption for those just observing the kits to be higher than for the control, but lower than those with their own test.
 - o There are several possible explanations for this surprising result:
 - Certain sites had a disproportionate number of farmers who only observed the test, because the FO decided to use a strategy of more typically doing the test as a demo at a meeting. Those sites may be correlated with another outside variable; perhaps they are all in very acidic areas.
 - Farmers who received the test of their own field might have in some cases learned that they did not have acidic soil and therefore decided to order less travertine than they would have otherwise.
 - There might be a “group think” effect when farmers see the pH test done in a meeting and there is a color change; perhaps they discuss the result and some influential farmers say that they will buy travertine, then others are influenced by them.
-) Adoption for those without exposure to the test was 14% versus 22% of those exposed (either in their own field or via observing others).
-) The effect of the pH test itself supports our hypotheses and further strengthens the result we saw in 2016B (10.8 kg increase in travertine orders compared to 8.7 kg in 16B).
-) Cost vs. benefit analysis shows that the expected impact of the kits outweighs the cost of the kit
 - o Social Return on Investment (SROI) is calculated at 2.68, or 268%
 - o Note that this is a very conservative estimate of the effect of the kit since we use the lower difference between those with their own field tested versus the control and not the larger difference between observing the test versus the control.
 - o However, there is definitely a strong indication that the travertine order difference after observing the test is at least as large as getting the test on one’s own field, and the FO can expose more farmers to the test via a meeting and make their test chemicals last longer.
 - o Very likely the SROI is higher, and perhaps substantially higher, than what we’ve estimated.

Next Steps

-) Continue to sell travertine (at 100 FRw/kg) in non-subsidy districts only in 2017B.
 - o Work with the government to learn more about the subsidy program and how we can work within it in 2018A and beyond.
 - o Continue putting emphasis on marketing and providing an incentive to FOs to promote travertine in those districts.

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- Suspend use of the pH test kits for 17B, but with the plan of using them again prior to 2018A marketing, ideally for all the districts.
-) In 2018A, consider the following initiatives to further promote travertine adoption:
 - Provide pH test kits to all Field Officers in all districts and strengthen the trainings and marketing messages used around these kits.
 - Increase number of clients exposed by pushing demonstrations of kits at all meetings and at contract signing day.
 - Do individual field visits strategically with clients that have many neighbors visiting or with clients who are influential and will share their experience with others.
 - Reduce the kit cost, and increase ROI, by re-using the basic kits year to year but refilling them with bulk chemical reagents.
 - Possibly trial SMS messages sent to clients telling them the pH that we think their fields are (based on soil maps) and how much travertine they should apply; this trial was done in Kenya.
 - Participate in government subsidy program or use One Acre Fund money to subsidize so that we can offer travertine at 75 FRw/kg or less.
 - Consider not offering free travertine gifts again; though there was a noticeable increase in orders the next season after the 50 kg free trial, the magnitude was small (3.2 kg) compared to the cost, and the more modest 5 kg free sample trial did not significantly affect orders in the following season.
-) Continue to refine our lime/travertine impact figures and recommendations by completing the following Phase 2 trials:
 - Lime quantity trial: started in 2016A, is looking at the effect of 0 kg/are, 5 kg/are, 15 kg/are and 25 kg/are lime applied in the first season on a maize-bean rotation over 4+ seasons
 - Micro-dose lime quantity trial (in Burundi, by in similar ag zone to high-altitude Rwanda): started in 2017A, is looking at the effect of 0 kg/are, 5 kg/are, 2.5 kg/are and 1.25 kg/are of lime on maize in one season
 - Micronutrient and lime trial: started in 2017A, is looking the comparative effect of a new micro-nutrient blend fertilizer and travertine in two doses (15 kg/are and 2 kg/are) from two different mines in Rwanda (Musu Supply Co. and Lindilo Ltd.).

Appendix

Lime Adoption Survey- more detailed results

Row Labels	Don't need lime	Don't know importance of lime	Lack of money	Don't trust quality	Tried lime before, no yield increase	Unit size inappropriate	Lime application too much work	Lime only useful on certain crops	Other
Bugarama	97%	4%	0%	0%	0%	0%	0%	0%	0%
Gatsibo	72%	4%	7%	0%	0%	0%	0%	0%	35%
Giheke	51%	21%	58%	0%	2%	0%	7%	2%	12%
Gisagara	71%	29%	25%	0%	0%	1%	0%	6%	4%
Huye	63%	36%	28%	0%	0%	1%	0%	0%	7%
Karongi	55%	34%	7%	0%	0%	0%	0%	0%	30%
Kibogora	48%	5%	53%	0%	0%	0%	0%	2%	12%
LWH East	85%	7%	11%	0%	0%	0%	0%	0%	30%
LWH West	85%	0%	9%	0%	0%	0%	0%	0%	17%
Mugonero	52%	9%	81%	0%	0%	0%	0%	2%	0%
Ngoma	88%	3%	16%	0%	0%	0%	0%	0%	7%
Ngororero	20%	61%	33%	0%	0%	0%	0%	0%	9%

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Nyamagabe	0%	1%	98%	1%	0%	1%	0%	0%	4%
Nyamasheke	90%	0%	30%	0%	0%	0%	0%	0%	6%
Nyanza	74%	18%	0%	0%	1%	2%	0%	1%	27%
Nyaruguru	2%	28%	40%	0%	0%	0%	0%	10%	40%
Rubengera	16%	53%	56%	1%	1%	0%	3%	0%	6%
Rusizi	29%	31%	53%	0%	0%	0%	0%	1%	3%
Rutsiro	60%	82%	50%	0%	0%	0%	0%	0%	4%
Grand Total	61%	27%	33%	0%	0%	0%	1%	1%	13%

Type of Client	Number in sample	Land size cultivated (ares)	% Land owned	Farmer is GL	16A Lime adopter	16A Lime Order (kg)	Used Lime in the Past	Quantity (kg) if bought lime from other source
16B Non-Adopter	2,454	45.8	87%	18%	2%	0.6	14%	126
16B Adopter	578	37.9	89%	24%	9%	3.8	26%	107

Type of Client	Number marketing meetings attended	Agrodealer shop in cell that sells lime	Learned about lime from FO	Got pH test	Doesn't know benefit of lime	Doesn't know quantity of lime should apply per are	Doesn't know what soil acidity does to plants	Strongly trusts the FO
16B Non-Adopter	2.6	14%	75%	3%	13%	41%	12%	92%
16B Adopter	2.7	21%	85%	12%	5%	18%	3%	94%