Rwanda | 2015A-2016B | Scaling Orange-Fleshed Sweet Potatoes

ONE ACRE FUND

Farmers First

PHASE:	1- Station	2- Farmer Field Trial	2.5- Small Sales Trial	3- District Sales Trial	4- Full Scale

Introduction and Objectives

Sweet potatoes are an important crop for maintaining food security in Rwanda, because they can be grown on marginal lands, and cultivation continues in the dry season. Consumption is high, at 130 kg/capita/year.[i] Surveys show that 40% of One Acre Fund farmers grew sweet potatoes in 2016AA[ii] and 60% grew them in 2016B.[iii]


Photo credit: International Potato Center (CIP)

Rwandans traditionally grow and consume white-fleshed sweet potatoes high in sugars but low in vitamins. New orange-fleshed varieties high in beta-carotene (a precursor to vitamin A) have been bred by the International Potato Center (CIP) and are suitable to Rwanda. This is important because vitamin A deficiency affects 6% of pre-school children in Rwanda and can cause serious problems like blindness, disease, and premature death.[iv]

We conducted side-by-side (Phase 2) trials of different improved orange sweet potatoes compared with local varieties, as well as trials to compare the relative effect of variety, fertilizer use, and planting method on sweet potato yields. These trials showed that variety has the largest effect on yields, and Naspot 10 is the best orange sweet potato variety. Simultaneously, with the Phase 2 trials we also ran small adoption trials at the sell level (Phase 2.5). One trial tested adoption and later-season propagation of Naspot cuttings at different prices versus when given away for free, and the other looked at whether we could affect farmer planting practices and fertilizer use on sweet potatoes through marketing and training. These were run at the same time so that we would be able to calculate a full impact model (which looks at impact/adopter x adoption) per each intervention, to compare them.

We found fertilizer use and One Acre Fund planting methods have both low first-season adoption and low impact. We also found sizeable adoption of Naspot both when sold at half-price (6 Rwandan francs/cutting) but especially when given away for free. Because we found that the free cutting model will lead to the most rapid propagation of the new variety (due to high seed saving) and it has a high SROI, we decided to move forward in 2017B with a free Naspot cutting distribution in one full district (Phase 3 trial), with the likely plan to continue this campaign in additional districts in the future. This is also in line with government and CIP policy—both are moving to promote the Naspot 10 variety quickly throughout Rwanda via giveaway campaigns.

Trial Summary:

Trial Type	2015A	2015B	2016A	2016B
Agronomic (Phase 2)	Variety (Ukerewe, Ndamirabana, Cacaerpedo)	Planting method vs fertilizer	Variety (Naspot 9, Naspot 10, Terimbere)	Planting method vs fertilizer vs variety (Naspot 10)
Adoption (Phase 2.5)			Naspot 9 sales (3 districts)	Naspot 10 sales vs free (6 districts) Fertilizer + 1AF planting push

51%	**Yield increase of Naspot 10 over local sweet potatoes, using local planting method (2016B trial)**
60%	**One Acre Fund farmers who grow sweet potato during the B season**

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16% vs 62%	**% Naspot 10 adoption at 6 RWF/cutting vs in the free giveaway sites**
130 kg	**Per capita annual sweet potato consumption in Rwanda**

Agronomic Trials: Variety

Objective(s): Determine the highest yielding and most preferred sweet potato varieties in different agro-ecological zones.

Hypotheses: Improved varieties of sweet potato – both white and orange fleshed – will produce higher yields and be more preferred than local sweet potato varieties.

Locations: Congo Nile, Cyangugu, and Lake Kivu agro-ecological zones.

Methodology and Treatments: For this trial, farmer volunteers each provided 300 m^2 of land that was divided into 4 plots of 75 m^2. The order of treatments from left to right in the plot was chosen randomly, to reduce any edge-effect bias.

In 2015A, we tested three improved varieties recommended by RAB at that time, two white and one orange. When results were disappointing, we switched to three completely new improved varieties, recommended by RAB and CIP, in 2016A.

All plots in a given farmer field were planted and maintained in identical ways, as follows:

- Planted in raised bands, with 2 cuttings per hole every 30 cm
- Compost quantity and quality chosen by the farmer, but identical across the 4 treatments
- 2 kg/are NPK 17 applied at first weeding
- Weeding, pest and disease control also to the discretion of the farmer, but identical across all 4 treatments. In practice we saw that no farmers applied any chemicals.
- A harvest box of 9 m^2 was taken for each treatment when the variety was found to be mature.
    - This means that different varieties were harvested on different days in some cases
    - Plants were counted, then tubers were all carefully dug up and weighed
    - After observing this harvest, farmers were asked their preference ranking for the varieties

Results:

Table #1: 2015A season sweet potato variety performance across locations

Location	Treatment	Season	Sample size	Yield (t/ha)	Significance vs control (p-value)	Farmer preference	Ares to plant next season
Congo Nile	Local (white)	2015A	14	9.09 bc[1]		21%	1.7
	Cacaerpedo (orange)	2015A	14	10.08 c	0.696	50%	1.8
	Ukerewe (white)	2015A	14	5.56 a	0.087*[2]	14%	0.9
	Ndamirabana (white)	2015A	14	6.98 ab	0.245	14%	1.6
Cyangugu	Local (white)	2015A	5	6.42 a		0%	11.0
	Cacaerpedo (orange)	2015A	5	6.63 a	0.951	100%	4.4
	Ukerewe (white)	2015A	5	5.71 a	0.670	100%	3.9
	Ndamirabana (white)	2015A	5	4.14 a	0.559	100%	3.4
Lake Kivu	Local (white)	2015A	14	5.95 b		50%	2.0
	Cacaerpedo (orange)	2015A	14	5.24 b	0.548	43%	0.8
	Ukerewe (white)	2015A	14	2.38 a	0.004***	0%	0.0
	Ndamirabana (white)	2015A	14	3.57 a	0.049**	0%	0.8

[1] Evaluated at p = 0.05 (95% confidence level). In this chart and subsequent charts, yield followed by a similar letter indicates no statistically significant difference between other yield numbers followed by the same letter.

[2] Statistical significance levels: 99% ***, 95% **, 90% *

TOTAL	Local (white)	2015A	33	7.35 b		36%	3.0
	Cacaerpedo (orange)	2015A	33	7.50 b	0.991	48%	1.7
	Ukerewe (white)	2015A	33	4.23 a	0.010***	16%	1.0
	Ndamirabana (white)	2015A	33	5.11 a	0.056*	10%	1.5

Table #2: 2016A season sweet potato variety performance across locations

Location	Treatment	Season	Sample Size	Yield (t/ha)	Significance vs. control (p-value)	Farmer preference	Ares to plant next season
Cyangugu	Local (white)	2016A	20	9.7 a		40%	7.0
	Naspot 10 (orange)	2016A	20	14.3 b	0.019**	95%	6.0
	Naspot 9 (orange)	2016A	20	8.8 a	0.650	45%	4.3
	Terimbere (orange)	2016A	20	11.1 a	0.478	25%	3.6
Lake Kivu	Local (white)	2016A	18	10.1 ab		39%	3.9
	Naspot 10 (orange)	2016A	18	11.8 b	0.509	61%	2.3
	Naspot 9 (orange)	2016A	18	5.8 a	0.087*	0%	2.4
	Terimbere (orange)	2016A	18	7.0 a	0.220	0%	3.2
Congo Nile	Local (white)	2016A	20	14.5 b		80%	1.8
	Naspot 10 (orange)	2016A	20	12.8 b	0.274	20%	2.2
	Naspot 9 (orange)	2016A	20	8.0 a	0.001**	20%	2.0
	Terimbere (orange)	2016A	20	9.4 a	0.001***	0%	1.5
TOTAL	Local (white)	2016A	58	11.5 a		53%	5.7
	Naspot 10 (orange)	2016A	58	13.0 a	0.191	59%	3.6
	Naspot 9 (orange)	2016A	58	7.6 b	0.001***	22%	2.9
	Terimbere (orange)	2016A	58	9.2 b	0.053**	9%	3.4

Interpretations:

- The 2015A trials shows that none of the three improved varieties outperformed local, and the two white varieties were statistically worse than local
- In 2016A also, no new variety significantly and consistently out-performed local, and in some zones Naspot 9 and Terimbere were worse than local
- Only Naspot 10 had yields that were statistically the same as local overall, and statistically higher in the Cyangugu ag zone
- We thus concluded from these trials than Naspot 10 is the most promising new orange sweet potato variety to pursue via future agronomic and adoption trials
- Farmer preference levels were also fairly high for Naspot 10, not just in Cyangugu but also in Lake Kivu and overall, in the lumped sample. This suggests farmers would be willing to adopt it, though we need to test this further in adoption trials
- At this stage, we did not experience any major sourcing problems for any of the sweet potato cuttings—largely because we were dealing with small quantities for trials—but we did notice that Naspot 9 and 10 are very difficult to distinguish. We need to create a clear identification guide and monitor multiplier fields closely to avoid mixing up these two varieties in the future.

Next Steps:

- From the 15B trials, we decided to drop further testing of any of the "improved" varieties, since none had promising results
- From the 16A trials, we decided to move forward with future trials of Naspot 10:

- We included it in more side-by-side trials in a wider range of ag zones in 16B. These trials looked not only at the effect of variety, but also fertilizer and planting method, to determine comparative importance of these factors
- We also had decided to move forward with a sales trial for Naspot 9 in 2016A, in order to test orange fleshed sweet potato adoption, based on station trial results that looked positive. This Phase 2 trial convinced us to switch the variety for the adoption trials from Naspot 9 to Naspot 10 for 2016B.

Agronomic Trials: Fertilizer and Planting Method

Objective(s): To determine the effects of the use of fertilizer and One Acre Fund planting practices on sweet potato yields in different agro-ecological zones.

Hypotheses:

- The use of DAP, NPK 17, and/or urea will increase sweet potato yields as compared with a control with no fertilizer application, and will be more strongly preferred by farmers.
- The use of the One Acre Fund planting method will increase sweet potato yields as compared to a control using local planting practices, and will be more strongly preferred by farmers.

Locations:

- 2015B: 7 cells across 4 zones (Bugarama, Cyangugu, Lake Kivu, Congo-Nile)
- 2016B: 6 cells across 4 zones (Cyangugu, Bugarama, Lake Kivu, and Central Plateau)

Methodology and Treatments: For this trial, farmer volunteers each provided 300 m^2 of land that was divided into 6 plots of 50 m^2. The order of treatments from left to right in the plot was chosen randomly, to reduce any edge-effect bias. Aside from the treatment differences, all plots in a given farmer field were planted and maintained in identical ways, as follows:

- Compost quantity and quality chosen by the farmer, but identical across the 4 treatments
- Weeding, pest, and disease control also to the discretion of the farmer, but identical across all 4 treatments. In practice we saw that no farmers applied any chemicals.
- A harvest box of 9 m^2 was taken for each treatment when the variety was found to be mature.
    - This means that different varieties were harvested on different days in some cases
    - Plants were counted, then tubers were all carefully dug up and weighed
    - After observing this harvest, farmers were asked their preference ranking for the varieties

2015B Treatments:

- Local farmer practice + no fertilizer
- 1AF planting (in ridges, 1 line of 2 crossed cuttings, 30 cm spacing), no fertilizer
- 1AF planting + 2 kg/are NPK 17 at top dress (first weeding)
- 1AF planting + 0.5 kg/are DAP + 0.85 kg/are KCl + 0.9 kg/are urea top dress

2016B Treatments:

- Local variety, local planting practice, no fertilizer
- Local variety, local planting practice, 200 kg/ha NPK 17 at first weeding
- Local variety, 1AF planting practice (same as in 2015B), 2 kg/are NPK 17 at first weeding
- Local variety, 1AF planting practice, no fertilizer
- Naspot 10 variety, local planting practice, no fertilizer
- Naspot 10 variety, 1AF planting practice, 2 kg/are NPK 17 at first weeding

Results:

Table #3: 2015B season sweet potato planting practice and fertilizer performance across locations

Location	Variation	Season	Sample size	Yield t/ha	Yield p-value	Profit (USD/ha)	Profit p-value	Farmer preference
Bugarama	Local planting practice, no fertilizer	2015B	10	7.72 a		$917 a		6%
	1AF planting + no fertilizer	2015B	10	7.89 a	0.999	$937 a	0.893	7%
	1AF planting + NPK 17	2015B	10	9.67 a	0.333	$920 a	0.786	81%
	1AF planting + DAP + Urea + KCl	2015B	10	9.94 a	0.226	$1,034 a	0.723	12%
Congo Nile	Local planting practice, no fertilizer	2015B	16	11.95 a		$906 a		6%
	1AF planting + no fertilizer	2015B	15	12.56 a	0.961	$962 a	0.714	7%
	1AF planting + NPK 17	2015B	16	15.89 b	0.012**	$983 a	0.605	81%
	1AF planting + DAP + Urea + KCl	2015B	16	13.58 a	0.547	$885 a	0.887	12%
Cyangugu	Local planting practice, no fertilizer	2015B	10	16.50 a		$1,485 a		40%
	1AF planting + no fertilizer	2015B	10	14.50 a	0.74	$1,305 a	0.531	10%
	1AF planting + NPK 17	2015B	10	15.33 a	0.933	$1,152 a	0.250	50%
	1AF planting + DAP + Urea + KCl	2015B	10	17.94 a	0.881	$1,468 a	0.952	50%
Lake Kivu	Local planting practice, no fertilizer	2015B	45	14.37 a		$1,137 a		7%
	1AF planting + no fertilizer	2015B	45	14.26 a	0.999	$1,144 a	0.963	4%
	1AF planting + NPK 17	2015B	45	19.83 b	0.001***	$1,333 a	0.209	67%
	1AF planting + DAP + Urea + KCl	2015B	45	17.26 b	0.011	$1,215 a	0.618	40%
TOTAL	Local planting practice, no fertilizer	2015B	81	13.33 a		$1,107 a		11%
	1AF planting + no fertilizer	2015B	80	13.17 a	0.995	$1,104 a	0.938	6%
	1AF planting + NPK 17	2015B	81	17.24 b	0.001***	$1,191 a	0.442	68%
	1AF planting + DAP + Urea + KCl	2015B	81	15.71	0.001***	$1,159 a	0.670	35%

Table #4: 2016B season sweet potato variety, planting practice and fertilizer performance across locations

Location	Treatment	Season	Sample size	Yield t/ha	Yield p-value	Profit (USD/ha)	Profit p-value	Farmer prefer-ence
Bugarama	Local variety, local planting, no fertilizer	2016B	20	7.03 b		$535 b		10%
	Local variety, local planting + fertilizer	2016B	20	7.58 b	0.639	$358 a	0.226	10%
	Local variety, 1AF planting + fertilizer	2016B	20	9.50 b	0.564	$813 c	0.058	5%
	Local variety, 1AF planting, no fertilizer	2016B	20	7.69 ab	0.041**	$823 c	0.050	10%
	Naspot 10, Local planting, no fertilizer	2016B	20	10.97 a	0.001***	$869 c	0.024	40%
	Naspot 10, 1AF planting + fertilizer	2016B	20	9.61 ab	0.033**	$798 c	0.073	40%
Central Plateau	Local variety, local planting, no fertilizer	2016B	20	9.71 bc		$719 a		0%
	Local variety, local planting + fertilizer	2016B	20	11.29 b	0.269	$735 a	0.913	0%
	Local variety, 1AF planting + fertilizer	2016B	20	10.79 c	0.136	$627 a	0.533	5%
	Local variety, 1AF planting, no fertilizer	2016B	20	7.57 b	0.443	$838 a	0.421	0%
	Naspot 10, Local planting, no fertilizer	2016B	20	19.27 a	0.001***	$1,709 c	0.001	70%
	Naspot 10, 1AF planting + fertilizer	2016B	20	16.80 a	0.001***	$1,387 b	0.001	30%

Cyangugu	Local variety, local planting, no fertilizer	2016B	39	8.38 b		$606 a		5%
	Local variety, local planting + fertilizer	2016B	40	8.27 b	0.932	$930 a	0.286	13%
	Local variety, 1AF planting + fertilizer	2016B	40	7.57 b	0.382	$698 a	0.726	13%
	Local variety, 1AF planting, no fertilizer	2016B	40	7.35 b	0.490	$569 a	0.964	10%
	Naspot 10, Local planting, no fertilizer	2016B	37	12.37 a	0.001***	$1,093 a	0.207	51%
	Naspot 10, 1AF planting + fertilizer	2016B	36	11.59 a	0.007***	$1,063 a	0.298	72%
Lake Kivu	Local variety, local planting, no fertilizer	2016B	40	6.78 ab		$439 a		0%
	Local variety, local planting + fertilizer	2016B	40	7.61 a	0.316	$437 a	0.992	20%
	Local variety, 1AF planting + fertilizer	2016B	39	7.42 b	0.345	$518 a	0.746	18%
	Local variety, 1AF planting, no fertilizer	2016B	39	6.00 ab	0.439	$795 b	0.089*	3%
	Naspot 10, Local planting, no fertilizer	2016B	40	8.09 a	0.112	$677 ab	0.216	20%
	Naspot 10, 1AF planting + fertilizer	2016B	40	8.07 a	0.199	$681 ab	0.209	40%
Congo Nile	Local variety, local planting, no fertilizer	2016B	36	7.09 a		$183 a		8%
	Local variety, local planting + fertilizer	2016B	36	9.00 a	0.211	$188 a	0.964	28%
	Local variety, 1AF planting + fertilizer	2016B	36	7.63 a	0.721	$453 bc	0.018**	17%
	Local variety, 1AF planting, no fertilizer	2016B	36	8.03 a	0.536	$303 ab	0.289	19%
	Naspot 10, Local planting, no fertilizer	2016B	36	9.01 a	0.208	$285 ab	0.367	14%
	Naspot 10, 1AF planting + fertilizer	2016B	36	7.43 a	0.821	$277 ab	0.408	28%
Total	Local variety, local planting, no fertilizer	2016B	155	7.66 a		$470 a		3%
	Local variety, local planting + fertilizer	2016B	156	8.57 a	0.117	$534 a	0.520	13%
	Local variety, 1AF planting + fertilizer	2016B	155	7.15 a	0.416	$601 ab	0.220	12%
	Local variety, 1AF planting, no fertilizer	2016B	155	8.30 a	0.268	$632 ab	0.135	6%
	Naspot 10, Local planting, no fertilizer	2016B	153	11.18 b	0.001	$845 c	0.001	42%
	Naspot 10, 1AF planting + fertilizer	2016B	152	10.12 b	0.001	$787 bc	0.006	48%

Because the 2016B sweet potato trial included fertilizer, planting method, and variety, we looked at the comparative impact of each of these factors on yield using regression analysis.

Table #5: Linear regression output assessing the relationship between listed variables and sweet potato yield in kg/are

Variable	Coefficient on kg/are	p-value
Fertilizer used	-2.70	0.107
One Acre Fund planting	-5.50	0.429
Naspot 10 variety	27.09	0.001***
Slope	-1.75	0.001***
Compost amount	0.32	0.320
Difference : planting date – Feb 15	-1.83	0.001***
Soil fertility level	-3.20	0.439
Bugarama (vs. Congo Nile)	25.01	0.004***
Central Plateau (vs. Congo Nile)	16.19	0.028**
Cyangugu (vs. Congo Nile)	8.89	0.121
Lake Kivu AEZ (vs. Congo Nile)	13.26	0.083

Interpretations:

- Naspot 10 variety:
  - In 2016B, the improved Naspot 10 variety had much higher yields than local varieties in Bugarama, Central Plateau, Cyangugu, and overall, although it was not significantly different from local varieties in Lake Kivu and Congo Nile.
  - In the regression analysis, aggregated across ag zones, Naspot 10 had a much higher impact on yield than both planting method and fertilizer use.
  - Despite these sizeable yield differences, profits were not statistically higher for Naspot 10 than for local seed in any zone except for the Central Plateau.
  - There was high preference among farmers for the Naspot 10 treatments, suggesting high potential adoptability, in zones other than Congo Nile. The preference advantage for Naspot was also fairly low in Lake Kivu.
- One Acre Fund planting:
  - In 2015B, using the One Acre Fund planting method without fertilizer did not significantly increase yields or profits.
  - In 2016B, One Acre Fund planting did not lead to significant yield or profit differences in any zone except for Bugarama, where it has significantly higher profits than local planting.
  - In 2015B and 2016B, farmer preference for the One Acre Fund planting method was low each time it was compared to treatments with all other variables equal, suggesting low adoption potential.
- Fertilizer:
  - In 2015B, there was a significant positive effect on both yields and profits of applying fertilizer to sweet potatoes in the Congo Nile and Lake Kivu zones, but not in Bugarama and Cyangugu.
    - NPK 17 gave higher yields than a composite application of DAP, urea, and KCl.
  - In 2016B, although the NPK 17 fertilizer treatment again gave higher average yields in most zones (except for Cyangugu), the difference was not significant.
  - In both season trials, farmers preferred fertilizer over no fertilizer with all other variables equal (same variety, same planting method), suggesting moderate adoption potential for fertilizer use, if properly promoted.

Next Steps:

- Run adoption trials on Naspot 10
- Consider future trials, possibly in 2017B, to re-run the multi-variable 2016B trial with a few revisions:
  - Expand to cover more agro-ecological zones, including Eastern Ridges, Eastern Savannah, and possibly the North (Volcanic Cones and Burebuka Highlands)
  - Test Naspot 10 with local planting and fertilizer as one of the treatments; consider dropping local variety with 1AF planting and no fertilizer to make space for this treatment
- Do more tests of planting methods at the station in both the West and East to attempt to refine and improve the 1AF planting recommendation, since our current recommendation is not very impactful
- Get soil data and use it to take another look at these data and try to understand why NPK 17 was impactful in Lake Kivu and Congo Nile but not Cyangugu and Bugarama

Adoption Trials: Variety

Objective(s):

- Evaluate smallholder farmer demand for orange-fleshed sweet potato varieties Naspot 9 and Naspot 10
- Project which model (sales at various prices, free gift) will lead to fastest propagation of the new varieties

Hypotheses:

- Farmer adoption will be moderate to low when offered for sale, but very high when offered for free
- Satisfaction and replanting rates will be high, especially in the Central Plateau zone
- The free gift model will lead to the highest propagation speed of the orange sweet potatoes in a site

Locations:

- 2016A Trial: 12 total cells in 4 per district in Nyaruguru, Rubengera (Congo Nile zone) and Rusizi (Cyangugu zone)
- 2016B Trial: 24 total cells in 6 districts: Bugarama (Bugarama zone), Huye (Central Plateau zone), Ngororero (Central Plateau and Congo Nile zones), Ngoma (Eastern Ridges zone), Rubengera (Lake Kivu and Congo Nile zones), Rusizi (Cyangugu zone)

Methodology and Treatments:

In 2016A, we offered Naspot 9 cuttings for sale in bundles of 50, for 600 RWF/bundle.

In 2016B, we offered Naspot 10 cuttings, using four different treatments, (one per cell, with 4 cells per district):

- Sales for 12 RWF/cutting (full price), sold in bundles of 50
- Sales for 6 RWF/cutting (half price), sold in bundle of 50
- Sales with dual pricing: 12 RWF/cutting unless purchased 5+ bundles of 50, then price switched to 6 RWF/cutting
- Free 25 cutting bundle, but farmers must opt-in to receive the free gift

Table #6: Sweet potato variety Naspot 9 adoption rates by district in 2016A

District	Season	Total clients	Number adopters	% Adoption all clients	% Adoption, only ag clients	Cuttings / adopter
Nyaruguru	2016A	684	68	10%	11%	99.3
Rubengera	2016A	584	42	7%	8%	67.9
Rusizi	2016A	843	45	5%	13%	91.1
TOTAL:	**2016A**	**2,111**	**155**	**7%**	**11%**	**88.4**

Table #7: Sweet potato variety Naspot 10 adoption rates by district in 2016B

District	Season	Total clients	Number adopters	% Total adoption	% Non-free adoption	Cutting/ adopter
Bugarama	2016B	234	81	35%	14%	42
Huye	2016B	742	288	39%	13%	85
Ngoma	2016B	518	238	46%	5%	41
Ngororero	2016B	623	324	52%	28%	73
Rubengera	2016B	467	67	14%	11%	60
Rusizi	2016B	744	284	38%	4%	31
TOTAL	2016B	**3,328**	**1,282**	**39%**	**12%**	**58**

Table #8: Sweet potato variety Naspot 10 adoption rates by treatment in 2016B

Sales Treatment	Season	16B clients	Number adopters	% Adoption	Cuttings/ adopter
Free	2016B	1,053	874	62%	189
Full price	2016B	680	131	8%	210
Half price	2016B	943	227	16%	479
Dual pricing	2016B	652	50	3%	34
TOTAL	2016B	**3,328**	**1,282**	**22%**	**102**

Table #9: Follow-up harvest and post-harvest results for select Naspot 10 adopters, 2016B

District	Ag zone	Variety	Sample size	Yield (kg/are)	Significance (p-value)	Will replant	Will give or sell to neighbors	Would buy Naspot again	Won't buy because saving
Bugarama	Bugarama	Local	9	6.9		67%	33%	0%	100%
		Naspot 10	10	237.5	0.005***	90%	10%		
Huye	Central Plateau	Local	19	122.5		95%	0%	53%	100%
		Naspot 10	19	159.7	0.001***	100%	0%		
Ngoma	Eastern Ridges	Local	19	149		37%	5%	16%	100%
		Naspot 10	19	259.9	0.001***	100%	0%		
Ngororero	Central Plateau	Local	20	92.6		95%	0%	25%	93%
		Naspot 10	20	126.2	0.001***	95%	5%		
Rubengera	Congo Nile	Local	17	176.8		35%	59%	11%	76%
		Naspot 10	19	163.8	0.001***	74%	11%		
Rusizi	Cyangugu	Local	19	48.6		74%	0%	58%	100%
		Naspot 10	12	110.7	0.001***	100%	0%		
TOTAL	Multiple	Local	103	106.6		68%	14%	27%	93%
		Naspot 10	99	174.8	0.001***	93%	4%		

Interpretations:

- These trials showed that there was a willingness to pay for orange sweet potato varieties, but adoption and propagation will be highest with a free giveaway
    - Adoption was fairly low (8%) at the highest price of 12 RWF/cutting
    - Adoption doubled (to 16%) with a decrease in price to 6 RWF/cutting
    - Adoption jumped dramatically to 62% when the cuttings were free but farmers had to opt-in
- Adoption varied by district, and this should be taken into account when making any order projections
- Follow-up surveys with select adopters confirmed a large and significant yield increase for Naspot 10 versus local varieties, even higher than what we saw at Phase 2
- Reported levels of replanting Naspot 10 were quite high
    - It is clear that this product would tend to have adoption only once, with no need to re-purchase (similar to trends we've seen in the past for beans, but very different from hybrid maize)
    - This is another argument for doing a free giveaway, since sales would not be sustainable anyway, with adoption unlikely to increase over time
- During these trials we had to source sweet potatoes at a larger scale than in the past, and we learned a number of interesting things about managing supply chain and storage:
    - Cuttings need to be harvested and delivered for planting within 1-3 days
        - During a distribution for demonstration parcels in Mugonero, the cuttings sat longer than that before Field Officers brought them to the sites, and many of them died or were weak and low-yielding
        - By contrast, in the Phase 2.5 trials we had a very quick turn-around between harvest of the cuttings and delivery, and losses were low and yields were high at the end of the season
    - Supply problems can arise, even despite having an advance contract:
        - One supplier with whom we worked was unable to deliver 50% of cuttings we had ordered, and we only learned this at the last minute
        - The problem was lack of rain, which meant the vines did not grow long enough before cutting
        - This means that we need to work to always contract with back-up suppliers, to find suppliers who can grow in marshland or valleys with wet soils, and to closely check in on the growth of the sweet potatoes during the season, prior to pick-up
    - The harvesting and loading process is very labor intensive:

- We found that the optimum plan is to use around 40 workers to harvest 30,000 cuttings in a day. Doing any more is difficult to manage
- Close supervision was required—our One Acre Fund agent had to work hard to convince the supplier to stick to the contract, which stipulated that 1 cutting was 30cm. The supplier wanted to count one cutting as a vine with 3-4 nodes, but some of those were 20cm or shorter
- In the future, we plan to pay the casual workers directly so that they will follow the rules and directions of the One Acre Fund supervisor, not the supplier

Next Steps:

- Run a Phase 3 free giveaway trial in 2017B
  - We decided to do this in Giheke district because:
    - Our top choice, Ngororero, was not an option—the district agronomist told us that they were already partnering with CIP for free cuttings and did not want another partnership
    - Rusizi and Giheke are neighboring districts, and we found the highest adoption for a free giveaway site (92%) in Rusizi in 2016B
    - In baseline surveys, we found that a sizeable number of farmers plant sweet potatoes in the B season there (in contrast to some districts, where A season is preferred)
  - We will organize trucks by sector, which will carry cuttings from the supplier, harvested the previous day, directly to the cells. Farmers will be mobilized in advance to prepare their fields and be ready to harvest the same day as distribution or one day later at maximum.
  - We have found a supplier to work with who has a large field in a marshland area, so they will not have production problems due to lack of rain

Adoption Trials: Fertilizer and Planting Method

Objective(s): Make efforts to actively promote "modern planting methods" for sweet potatoes and measure whether marketing has any effect on client behavioral changes

Hypotheses:

- Some clients, perhaps 10-20%, can be convinced to adopt row planting and fertilizer use via marketing and promotional efforts
- Demonstration parcels will show a positive yield difference for these "modern" planting methods compared with local methods
- Even more farmers will be convinced to adopt the "modern" methods in future seasons, after observing the positive results in demonstration parcels and of their first-adopter neighbors

Locations: Mugonero district (Lake Kivu zone)

Methodology and Treatments:

We attempted to promote a package of "modern" sweet potato planting methods that included:

- One Acre Fund planting: Raised bands with 2 cuttings every 30cm (as tested in Phase 2 trials)
- Fertilizer use-:2 kg/are NPK 17 applied at first weeding

At the time of the marketing launch for 2016B, field officers in Mugonero all received a special marketing flier about "modern sweet potato planting" that they were supposed to share with farmers during Ihuriro marketing meetings. We also did a special training with Mugonero field officers to practice these methods.

The Ihuriro demonstration parcel for Mugonero in 2016B (of which there were 3-4 per cell across all 50 cells) included 50 m^2 of sweet potatoes: 25 m^2 were planted with a local variety, with local planting and no fertilizer, while 25 m^2 were planted with Naspot 10 with 1AF planting methods and fertilizer.

We also selected 16 farmers in two different sites in Mugonero with whom to do an additional follow-up trial to test the effect of modern planting methods. Those farmers planted 25 m^2 with a local variety, with local planting and no fertilizer, side-by-side with the same local variety, the 1AF planting method, and fertilizer.

After planting in 2016B, we conducted a random survey in several cells in Mugonero to see if farmers had received the marketing message, and if any of them had decided to try out "modern sweet potato planting" for the first time.

Table #10: 2016B phase 3 survey results on "modern sweet potato planting"

Farmers surveyed	% Heard about "modern sweet potato planting" from the FO	% Planted sweet potato in rows in past seasons	% Planted sweet potato in rows in 2016B	% Reportedly changed practice because of One Acre Fund	Average ares changed to modern methods	% Would consider trying "modern sweet potato planting" in future
92	9%	33%	47%	22%	2.2	99%

Table #11: 2016B yield differences for select Phase 3 "modern sweet potato practice" adopters

Treatment	Fields harvested	Yield (t/ha)
Local variety, local planting method	16	6.14
Local variety, modern planting method (1AF planting + fertilizer)	16	7.56

Table #12: 2016B yield differences for select demonstration parcels, Naspot 10 + modern practices

Treatment	Fields harvested	Yield (t/ha)
Local variety, local planting method	23	7.67
Naspot 10, modern planting method (1AF planting + fertilizer)	23	6.08

Interpretations:

- The direct marketing by field officers during contract meetings was not well delivered, considering that only 9% of survey respondents heard the message
- However, 22% of farmers said that they adopted 1AF-style planting practices and/or fertilizer use on sweet potatoes in 2016B because of One Acre Fund
    - They must have received the message in a different forum than the marketing meetings
    - Likely they were exposed during planting of the demonstration parcels, or their field officers promoted the methods to them in one-on-one visits
- There is an even higher reported interest in trying modern methods in the future, suggesting there is room for pushing adoption much further if we decide to prioritize this
- The follow-up plots planted with selected adopters confirm the positive yield effect of "modern planting methods"
- However, the demonstration plots showed a negative yield effect of our full Naspot 10 + modern planting method package, when compared to local varieties and local planting
    - This is in contrast to findings in the overall results for the Phase 2 trial in 2016B, but actually is in line with the results seen in the Lake Kivu ag zone
    - This suggests, like some of the 2016B Phase 2 results, that perhaps when Naspot 10 is sold, farmers should be encouraged to plant using local methods and no fertilizer, rather than modern methods

Conclusions and Next Steps:

- Given the mixed impact results for both fertilizer and 1AF planting methods, we should not prioritize repeating or expanding this trial
- If in future Phase 2 trials we find a larger impact of these methods, then we can consider adoption promotion again

- Mugonero (or any other district in Lake Kivu) is not the best choice if we repeat this trial again someday. A better choice might be Bugarama, where a significant impact of 1AF planting methods were found at Phase 2
- The most promising yield-improvement intervention One Acre Fund can promote for sweet potato is adoption of the Naspot 10 orange-fleshed variety
    - Impact from this variety appears high, and that is before even calculating for the value of beta-carotene
    - Comparative effect on yields is much higher, and consistent across more zones, than fertilizer or planting method changes
    - Adoption is easier to promote for this variety than for behavioral changes in planting or fertilizer use
- In 2017A, we conducted a large baseline survey across all One Acre Fund districts in Rwanda to learn more about current sweet potato cultivation practices, current yields and yield-gap drivers, knowledge of orange varieties, and reported interest in ordering Naspot 10 (after explanation of a catalog page)
- In the 2017B season, One Acre Fund will offer free bundles of Naspot 10 to clients in all the sites in Giheke district
    - The estimated expected SROI for this program (including all cutting, transport, and labor costs) is 6.1, although we will calculate the actual SROI during the course of the trial
    - We expect to distribute around 500,000 cuttings through this campaign
    - Clients must opt-in, so adoption will not be automatically 100%
    - We will use this opportunity to further refine our supply and delivery system for sweet potato cuttings
- In 2018A, we intend to expand this free giveaway to more sites
    - We might avoid rolling out the Naspot variety in Congo Nile and Lake Kivu due to the lack of impact seen in 2016B trials. However, we will first re-run the trial in 2017B to confirm the lack of impact
    - The scope of that campaign will depend on the results of the 17B trial in Giheke—what was adoption, survival rate of cuttings, total cost to One Acre Fund, and estimated SROI
    - It will also depend on supply—what is the maximum number of cuttings we can even find to order from multipliers for 2018A?
    - We will use data from the 2017A baseline survey across all districts to better refine roll-out plans, timing the distribution calendar according to popular planting months per district and targeting marketing messages based on what farmers in those surveys said resonated with them
- In 2017B, we will also run more agronomic impact trials on sweet potatoes:
    - A repetition and expansion of the 2016B trial comparing variety, planting method, and fertilizer
    - Addition of Naspot 10 with local planting methods and fertilizer as a variation
    - Inclusion of Eastern Ridges, Eastern Savannah, and possibly the zones in the north of Rwanda in those trials
    - Station trials to test more iterations of planting practice, to see if we can create a more impactful 1AF recommendation

[i] Ingabire, Rose and Hilda Vasanthakaalam. 2011. "Comparison of the nutrient composition of four sweet potato varieties cultivated in Rwanda." *American Journal of Food and Nutrition*1, 1: 34-38.

[ii] A Season in Rwanda refers to crops planted in Aug-Oct of the preceding year and harvested in Jan-Feb of the relevant year, so 2016A crops are planted in Aug-Oct 2015. B Season in Rwanda refers to crops plants in Feb-March of the given year and harvested in May-June of that same year.

[iii] 2016A & 2016B Crop Mix Surveys. Monitoring & Evaluation Team- One Acre Fund Rwanda.

[iv] "2014 Nutrition Country Profile: Rwanda." 2014. Global Nutrition Report, International Food Policy Research Institute.