Online Appendix

Digital Information Provision and Behavior Change: Lessons from Six Experiments in East Africa

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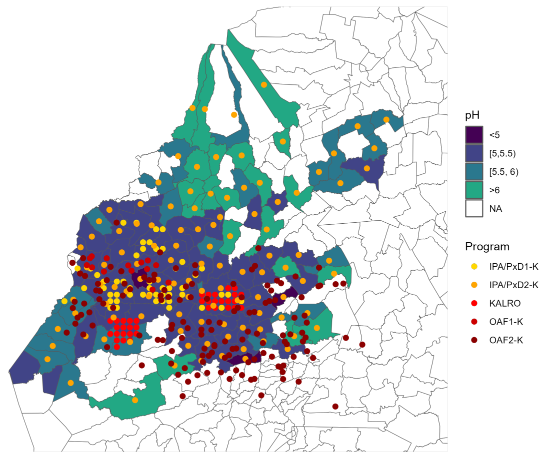
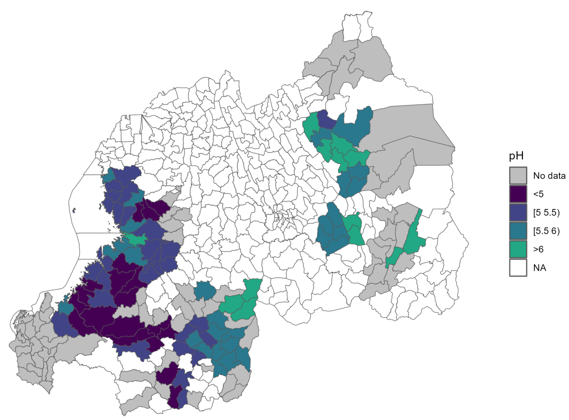
A Projects Maps

Figure A1: Projects Maps



(a) western Kenya



(b) Rwanda

Notes: Panel (a) shows the median level of pH by ward (geographical area) and the location of the programs in western Kenya. Panel (b) shows the sectors in Rwanda in which the 1AF3-R program took place and the median level of pH, where available.

B Regression Controls and Variables

Table B1: Data Collected on Inputs, Control Variables and Strata

Sample	Recommended Inputs	Non-Recommended Inputs		Control Variables	
		Other	Fertilizers	Strata	Other
KALRO	lime, planting fertilizer (DAP, NPK), top-dressing fertilizer (CAN, Mavuno), compost, manure, hybrid seeds, weed control, intercropping test acidity grain storage	rhizobia pest and disease control, improved legumes		female, lime awareness, input use index (tercile), grew legumes, farm size (median) cognitive score (tercile), school area FE	prior soil testing, enumerator FE
IPA/PxD1-K	lime, DAP, urea		NPK, CAN, Mavuno	female, database origin, farm size (tercile) ag. knowledge (median), prior urea use, prior lime use, positive valuation completed poll, area FE	age, primary education language, safaricom phone network, enumerator FE (survey outcomes)
IPA/PxD2-K	lime, DAP, urea (mentioned CAN use for poor rains)	hybrid seeds, pesticides	NPK, Mavuno	female, prior lime use, agrovet recruiter FE	age, land size, language, farmer area FE, enumerator FE (survey outcomes)
1AF1-K	lime	actellic, compost, drying sheets, storage bags	extra CAN		maize package (acres), seasons in 1AF, group size, prior purchase of extra CAN, area FE, enumerator FE (survey outcomes)
1AF2-K	lime, extra CAN	actellic, compost, drying sheets, storage bags		seasons in 1AF, area FE	maize package (acres), seasons in 1AF, group size, prior purchase of extra CAN, prior lime purchase, area FE
1AF3-R	lime	DAP, NPK, urea, storage bags			seasons in 1AF, group size, prior lime purchase, area FE

Notes: Column (2), shows the list of recommended inputs or practices for each text-message program for which we have administrative or survey data at endline. Column (3) the list of non-recommended (not mentioned) inputs for which we have data at endline (split by fertilizers and other types). Column (4) presents the list of randomization strata (these are included as controls in the main specifications), as well as the list of additional control variables included in the robustness specifications (all of them measured prior to the program introduction). Included controls are constrained by data availability for each project. FE denotes fixed effects.

C Attrition & Balance

Table C1: KALRO: Summary Statistics & Balance

	Control (1)	Treated (2)	(1) vs. (2) (3)
Age	41.85	40.41	1.44
	(0.67)	(0.67)	(0.95)
Female	0.65	0.66	-0.01
	(0.02)	(0.02)	(0.03)
Primary school	0.51	0.54	-0.03
	(0.03)	(0.03)	(0.04)
Secondary school	0.03	0.04	-0.01
	(0.01)	(0.01)	(0.01)
Footwear	0.60	0.56	0.04
	(0.03)	(0.03)	(0.04)
Mumias	0.57	0.57	-0.01
	(0.03)	(0.03)	(0.04)
Acres (owned and rented)	2.25	1.98	0.27
	(0.28)	(0.10)	(0.30)
Literate	0.90	0.91	0.00
	(0.02)	(0.01)	(0.02)
Had soil test	0.13	0.11	0.02
	(0.02)	(0.02)	(0.02)
Mentions lime	0.03	0.04	-0.01
	(0.01)	(0.01)	(0.01)
Used lime	0.07	0.07	0.00
	(0.01)	(0.01)	(0.02)
Used fertilizer last LR season	0.84	0.84	0.00
	(0.02)	(0.02)	(0.03)
Grew legumes last LR season	0.79	0.77	0.02
	(0.02)	(0.02)	(0.03)
Heard lime	0.40	0.41	0.00
	(0.03)	(0.02)	(0.04)
Heard soil test	0.67	0.72	-0.05
	(0.02)	(0.02)	(0.03)
Ever used DAP	0.94	0.94	0.00
	(0.01)	(0.01)	(0.02)
Ever used CAN	0.61	0.64	-0.03
	(0.02)	(0.02)	(0.03)
Ever used NPK	0.12	0.15	-0.03
	(0.02)	(0.02)	(0.02)
N	384	389	773
Joint F-Stat (w/strata)			1.12
p-value			0.34
Joint F-Stat (w/controls & FE)			1.21
p-value			0.27

Notes: The table shows summary statistics by treatment group and their differences using data from the baseline survey. The sample is restricted to non-attriting observations from the endline survey. Columns (1)–(2) display the mean and standard error of each characteristic for each treatment group. Column (3) displays the differences across columns and the corresponding standard error. *Primary school* and *Secondary school* refer to completing primary and secondary education, respectively. *Footwear* denotes whether the respondent was wearing shoes (a proxy for income) at the time of the survey. *Mumias* denotes the share of farmers from the Mumias area, *Had soil test* denotes ever having a soil test, *Mentions lime* is a dummy variable with value one if the respondent mentioned lime at baseline as a strategy to reduce soil acidity. *Heard soil test* and *Heard lime* take the value one if the respondent has ever heard of using soil tests to test for acidity or has heard about lime, respectively. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as strata (see Table B1), using a specification that matches that of the main analysis, including strata. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables, excluding those used as strata or controls, using a specification that includes controls, strata, area, and enumerator fixed effects. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table C2: IPA/PxD1-K: Summary Statistics & Balance

	Control	General	Specific	(1) vs. (2)	(1) vs. (3)	(2) vs. (3)
	(1)	(2)	(3)	(4)	(5)	(6)
Age	46.25	46.01	45.59	0.25	0.66	0.42
	(0.49)	(0.45)	(0.43)	(0.66)	(0.65)	(0.63)
Female	0.37	0.37	0.37	-0.01	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Primary school	0.60	0.61	0.66	-0.01	-0.05*	-0.04
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Secondary school	0.10	0.10	0.10	0.00	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Mumias	0.53	0.53	0.53	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Prefers english	0.30	0.27	0.30	0.03	0.00	-0.03
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Mentions lime	0.16	0.17	0.17	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Acres (owned and rented)	2.00	1.86	2.14	0.14	-0.14	-0.28
	(0.09)	(0.08)	(0.31)	(0.12)	(0.32)	(0.32)
Used lime	0.12	0.13	0.12	-0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Used DAP last LR season	0.78	0.78	0.80	0.00	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Used NPK last LR season	0.04	0.05	0.04	-0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Used CAN last LR season	0.62	0.62	0.59	0.00	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Used urea last LR season	0.18	0.18	0.18	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Used mavuno last LR season	0.15	0.13	0.16	0.02	-0.01	-0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Enrolled in main phone network	0.95	0.94	0.94	0.01	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Lime recommended	0.82	0.82	0.82	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
N	632	633	632	1265	1264	1265
Joint F-Stat (w/ strata)				0.50	1.04	1.23
p-value				0.91	0.41	0.26
Joint F-Stat (w/add. controls & FE)				0.33	0.89	1.54
p-value				0.95	0.52	0.14

Notes: The table shows summary statistics and balance tests using variables from a baseline survey. Columns (1)–(3) display the mean and standard error of each characteristic for each treatment group. Columns (4)-(6) display the difference across columns and the corresponding standard error. *Mumias* denotes the share of farmers from the Mumias Sugar Company sample. *pH prediction* represents the median pH level measured in the farmer's catchment area. *Mentions lime* is a dummy variable with value one if the respondent mentioned lime as a strategy to reduce soil acidity. Input use variables refer to whether respondents used the specific input during the previous long rain (LR) season. *Lime recommended* indicates whether the farmer resided in an area where the use of lime was recommended. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as randomization strata (see Table B1, using a specification that matches that of the main analysis, including strata. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables excluding those used as controls and strata, using a specification that includes controls, strata, and area-fixed effects. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table C3: IPA/PxD2-K: Additional Summary Statistics & Balance

	Control (1)	SMS (2)	SMS+Call (3)	SMS+Call Offer (4)	(1) vs. (2) (5)	(1) vs. (3) (6)	(1) vs. (4) (7)
Age	42.10	41.40	41.48	41.44	0.70	0.61	0.66
	(0.32)	(0.31)	(0.32)	(0.31)	(0.45)	(0.46)	(0.45)
Female	0.34	0.34	0.34	0.34	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Primary school	0.72	0.70	0.69	0.71	0.01	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Secondary school	0.13	0.13	0.12	0.13	-0.01	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Prefers english	0.36	0.35	0.34	0.35	0.01	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Mentions lime	0.26	0.26	0.24	0.25	0.00	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Acres (owned and rented)	2.02	1.85	2.09	2.03	0.17**	-0.07	-0.02
	(0.06)	(0.05)	(0.09)	(0.06)	(0.08)	(0.11)	(0.08)
Used lime	0.09	0.09	0.09	0.10	-0.01	0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Used CAN last LR season	0.64	0.62	0.65	0.62	0.02	0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Used urea last LR season	0.18	0.20	0.20	0.18	-0.02	-0.02	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Used mavuno last LR season	0.08	0.08	0.07	0.09	0.00	0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Lime recommended	0.77	0.76	0.77	0.76	0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
N	1470	1475	1473	1472	2945	2943	2942
Joint F-Stat (w/strata)					0.99	1.18	0.68
p-value					0.45	0.30	0.74
Joint F-Stat (w/add. controls & FE)					0.63	0.87	0.39
p-value					0.70	0.51	0.88

Notes: The table shows summary statistics and balance tests using variables from a baseline survey. Columns (1)–(4) display the mean and standard error of each characteristic for each treatment group. Columns (5)-(7) display the difference across columns and the corresponding standard error. *Primary school* and *Secondary school* refer to completing primary and secondary education, respectively. *Prefers english* indicates respondent preferred messages in English rather than Swahili. *Mentions lime* is a dummy variable with value one if the respondent mentioned lime as a strategy to reduce soil acidity. Input use variables refer to whether respondents used the specific input during the previous long rain (LR) season. *Lime recommended* indicates whether the farmer resided in an area where the use of lime was recommended. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as strata (see Table B1), using a specification that matches that of the main analysis, including strata. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables excluding those used as controls and strata, using a specification that includes controls, strata, area, and agrovet-fixed effects. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table C4: 1AF1-K: Additional Summary Statistics & Balance

	Broad (1)	Control (2)	Detailed (3)	(1) vs. (2) (4)	(1) vs. (3) (5)	(2) vs. (3) (6)
Female	0.64	0.64	0.67	0.00	-0.02	-0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Group size	9.24	9.08	9.07	0.16	0.17*	0.01
	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)	(0.10)
1AF seasons	1.50	1.51	1.52	0.00	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Maize inputs (acres)	0.49	0.50	0.50	-0.01	-0.02	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
pH prediction	5.48	5.48	5.48	0.00	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Intercropped beans	0.03	0.03	0.03	0.01	0.01	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Extra CAN purchased	0.10	0.08	0.10	0.02*	0.00	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Repayment incentive	0.05	0.04	0.04	0.01	0.01	0.00
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Storage bags	0.09	0.07	0.07	0.02**	0.02**	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
PICS bags	0.08	0.08	0.09	0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Compost booster	0.05	0.05	0.05	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Red onions	0.11	0.07	0.10	0.03***	0.01	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Reusable pads	0.05	0.04	0.04	0.01	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Drying sheets	0.24	0.23	0.24	0.01	0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Actellic super	0.10	0.09	0.11	0.01	-0.01	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Solar lamps	0.46	0.45	0.46	0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Health insurance	0.23	0.22	0.21	0.01	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	1684	1559	1641	3243	3325	3200
Joint F-Stat (w/strata)				1.45	0.98	1.43
p-value				0.10	0.48	0.11
Joint F-Stat (w/add. controls & FE)				1.47	0.94	1.51
p-value				0.12	0.51	0.10

Notes: The table shows summary statistics and balance tests using covariate variables from 1AF long rain 2016 administrative records (before the trial took place). Columns (1)-(3) display mean and standard errors of each variable, by treatment group. Columns (4)-(6) display the difference across columns and the corresponding standard error. *Group size* denotes the number of farmers in the participant's 1AF group. *1AF seasons* denotes the number of prior seasons of enrollment in the 1AF program. *Maize inputs (acres)* refers to the size, in acres, of the agricultural inputs package purchased from 1AF, and *pH prediction* is the variable obtained using kriging interpolation that was used to produce detailed recommendations, *Intercropped beans*,*Extra CAN purchased*, *Repayment incentive*, *Storage bags*, *PICS bags*, *Compost booster*, *Red onions*, *Drying sheets*, *Reusable pads*,*Actellic super*, *Solar lamps* and *Health insurance* are dummy variables equal to one if the farmer had purchased or received any of those products from 1AF in the season prior to the experiment. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as strata if strata were used in the randomization (see Table B1) using a specification that matches that of the main analysis. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables excluding those used as controls, using a specification that includes controls and area-fixed effects. Differences in variables across 1AF balance tables stems from differences in shared variables by project and/or differences in regional programs. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table C5: 1AF2-K: Summary Statistics & Balance

	Control (1)	Lime + CAN (2)	Lime only (3)	(1) vs. (2) (4)	(1) vs. (3) (5)	(2) vs. (3) (6)
Age	48.40	48.44	48.30	-0.04	0.10	0.14
	(0.15)	(0.20)	(0.10)	(0.25)	(0.18)	(0.22)
Female	0.69	0.68	0.69	0.01	0.00	-0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Group size	9.87	9.92	9.82	-0.05	0.04	0.10**
	(0.03)	(0.04)	(0.02)	(0.05)	(0.04)	(0.05)
1AF seasons	2.23	2.22	2.23	0.01	0.00	-0.01
	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)
Maize inputs (acres)	0.51	0.53	0.51	-0.01**	0.00	0.01**
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
pH prediction	5.33	5.33	5.33	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Intercropped beans	0.02	0.02	0.02	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Extra CAN purchased	0.15	0.14	0.15	0.01	0.00	-0.01
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Repayment incentive	0.04	0.05	0.05	0.00	-0.01***	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Storage bags	0.11	0.11	0.12	0.00	0.00	-0.01
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
PICS bags	0.09	0.09	0.09	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
Compost booster	0.04	0.04	0.04	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Red onions	0.03	0.04	0.03	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Reusable pads	0.03	0.03	0.03	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Drying sheets	0.22	0.23	0.22	-0.01	0.00	0.01
	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Actellic	0.18	0.18	0.18	0.00	0.00	0.00
	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Solar lamps	0.42	0.43	0.42	0.00	0.00	0.01
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Credit size (Ksh)	9501.74	9616.95	9466.33	-115.21	35.41	150.62**
	(49.86)	(64.63)	(31.67)	(81.57)	(58.69)	(71.19)
N	8142	4872	19558	13014	27700	24430
Joint F-Stat (w/ strata)				1.15	0.92	1.74
p-value				0.30	0.55	0.03
Joint F-Stat (w/add. controls & FE)				1.28	0.58	1.31
p-value				0.21	0.87	0.20

Notes: The table shows summary statistics and balance tests using covariate variables from 1AF long rain 2017 administrative records (before the trial took place). Columns (1)-(3) display mean and standard errors of each variable, by treatment group. Columns (4)-(6) display the difference across columns and the corresponding standard error. *Group size* denotes the number of farmers in the participant's 1AF group. *1AF seasons* denotes the number of prior seasons of enrollment in the 1AF program.*Maize inputs (acres)* refers to the size, in acres, of the agricultural inputs package purchased from 1AF, and *pH prediction* is the variable obtained using kriging interpolation that was used to produce detailed recommendations.*Intercropped beans*,*Extra CAN purchased*, *Repayment incentive*, *Storage bags*, *PICS bags*, *Compost booster*, *Red onions*, *Drying sheets*, *Reusable pads*,*Actellic super* and *Solar lamps* are dummy variables equal to one if the farmer had purchased or received any of those products from 1AF in the season prior to the experiment. *Credit size (Ksh)* is the size of credit in Kenyan shillings taken from 1AF in the season prior to the experiment. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as strata (see Table B1), using a specification that matches that of the main analysis, including strata. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables excluding those used as controls and strata, using a specification that includes controls, strata and area-fixed effects. Differences in variables across 1AF balance tables stems from differences in shared variables by project and/or differences in regional programs. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table C6: 1AF3-R: Summary Statistics & Balance

	Full Control	Full Treatment	Partial Treatment		(1) vs. (2)	(1) vs. (3)	(1) vs. (4)
			Non Treated	Treated			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Group size	10.71	10.75	10.72	10.71	-0.04	-0.01	-0.00
	(0.06)	(0.05)	(0.04)	(0.04)	(0.08)	(0.08)	(0.07)
1AF seasons	2.01	2.01	2.01	2.01	-0.00	-0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Purchased lime	0.06	0.06	0.06	0.06	0.00	0.01*	0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Purchased urea	0.74	0.74	0.74	0.74	-0.00	0.01	-0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Planting fertilizer (kg)	13.71	13.80	13.64	13.71	-0.09	0.07	-0.00
	(0.20)	(0.14)	(0.14)	(0.14)	(0.25)	(0.24)	(0.24)
Seeds (kg)	2.49	2.43	2.45	2.45	0.06	0.04	0.04
	(0.04)	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)	(0.05)
PICS bags	0.06	0.07	0.07	0.07	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Solar Lamp	0.28	0.27	0.29	0.28	0.01	-0.01	-0.00
	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Credit size (Rwf)	22511.28	22302.93	22722.68	22668.85	208.35	-211.40	-157.57
	(206.60)	(152.82)	(154.35)	(153.87)	(256.96)	(257.88)	(257.59)
N	19066	36336	27527	27471	55402	46593	46537
Joint F-Stat (w/ strata)					0.67	0.83	0.59
p-value					0.73	0.59	0.81
Joint F-Stat (w/add. controls & FE)					1.17	0.77	0.41
p-value					0.32	0.59	0.87

Notes: The table shows summary statistics and balance tests using covariate variables from 1AF 2016 administrative records (before the trial took place). Columns (1)-(4) display mean and standard errors of each variable, by treatment group. Columns (5)-(7) displays the difference across columns and the corresponding standard error. *Group size* denotes the number of farmers in the participant's 1AF group, *1AF seasons* denotes the number of seasons of enrollment in the 1AF program, *Purchased lime* and *Purchased urea* is a dummy indicating whether the farmer purchased lime or urea from 1AF in seasons prior to the experiment. *Planting fertilizer (kg)* and *Seeds (kg)* indicates the quantity of planting fertilizer and seeds purchased across two previous seasons, and *PICS bags* and *Solar lamp* indicates whether the farmer had purchased those products from 1AF previously. *Credit size (Rwf)* reports the size of the 1AF loan across two previous seasons in Rwandan francs. Standard errors are clustered at the farmer group level. The joint F-stat (w/strata) and p-value refer to a test of the joint significance of baseline variables, excluding those used as strata if strata were used in the randomization (see Table B1) using a specification that matches that of the main analysis. The joint F-stat (w/add.controls & FE) refers to a test of the joint significance of baseline variables, excluding those used as controls, using a specification that includes controls and area-fixed effects. Differences in variables across 1AF balance tables stems from differences in shared variables and/or differences in regional programs. $^{*}p < .10$, ** $p < .05$, *** $p < .01$.

Table C7: Probability of Differentially Collecting Endline Information

	LPM					Odd ratios				
	Survey	Survey + Plant	Enroll 1st (1AF)	Enroll 2nd (1AF)	Enroll 2nd (1AF) persist.	Survey	Survey + Plant	Enroll 1st (IAF)	Enroll 2nd (1AF)	Enroll 2nd (1AF) persist.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A. KALRO										
Treated	0.016					1.286				
	(0.018)					(0.350)				
Mean Control	0.921					0.921				
Observations	832					832				
Panel B. IPA/PxD1-K										
Treated	0.003	0.014				1.021	1.086			
	(0.020)	(0.020)				(0.123)	(0.126)			
Mean Control	0.794	0.766				0.794	0.766			
Observations	1897	1897				1897	1897			
Panel C. IPA/PxD2-K										
Treated	-0.005	-0.002				0.962	0.985			
	(0.011)	(0.012)				(0.079)	(0.077)			
Mean Control	0.841	0.820				0.841	0.820			
Observations	5890	5890				5890	5890			
Panel D. 1AF1-K										
Treated	-0.015	-0.013	-0.002	0.014	0.010	0.915	0.935	0.991	1.060	1.046
	(0.023)	(0.024)	(0.015)	(0.015)	(0.026)	(0.125)	(0.119)	(0.062)	(0.066)	(0.128)
Mean Control	0.795	0.750	0.602	0.397	0.686	0.795	0.750	0.602	0.397	0.686
Observations	1466	1466	4884	4884	2871	1466	1466	4884	4884	2871
Panel E. 1AF2-K										
Treated			0.002	0.007				1.009	1.029	
			(0.005)	(0.006)				(0.030)	(0.027)	
Mean Control			0.761	0.558				0.761	0.558	
Observations			32572	32572				32572	32572	
Panel F. 1AF3-R										
Treated			0.009	0.004	-0.006			1.042	1.017	0.974
			(0.007)	(0.008)	(0.009)			(0.032)	(0.031)	(0.042)
Mean Control			0.645	0.472	0.701			0.645	0.472	0.701
Observations			82873	82873	51923			82873	82873	51923

Notes: The dependent variable 'Survey' in Panel A takes the value of one if the farmer completed the in-person endline survey. In panels B to D, it indicates whether the farmer completed the phone-based endline survey. 'Survey + Plant' denotes the sample who completed the survey and reported planting maize in the relevant season (IPA/PAD and 1AF1-K condition outcomes on this variable). In panel D, the sample in columns (1)-(2) and (6)-(7) is restricted to the subsample that was randomly selected to complete the endline survey. Panels D-F, columns (3) and (8) have as a dependent variable whether the farmer enrolled in the 1AF input program (i.e. placed an input order) in the season in which the text-message program took place, while in columns (4) and (9) the dependent variable indicates whether they enrolled in the input program the following year. Columns (5) and (10) show the likelihood of enrollment in the second season of the 1AF input program, restricting to the sample that was re-randomized, and from which the persistence of effects are estimated (re-randomization was conditional on first season input enrollment). Columns (1)-(5) report effects from linear probability models, and columns (6)-(10) report odds ratios estimated using logit. * $p < .10$, ** $p < .05$, *** $p < .01$.

D Results by Experiment: Pooled Treatment Arms

Table D1: Awareness and Knowledge about Lime

	LPM				Logit (OR)			
	Awareness (Lime)		Knowledge (Acidity)		Awareness (Lime)		Knowledge (Acidity)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. KALRO								
Treated	-0.003	-0.004	0.021	0.023	0.981	0.977	1.189	1.149
	(0.032)	(0.032)	(0.024)	(0.024)	(0.166)	(0.170)	(0.268)	(0.278)
Mean Control	0.58	0.58	0.14	0.14	0.58	0.58	0.14	0.14
Observations	773	773	773	773	773	773	773	773
Add. Controls	N	Y	N	Y	N	Y	N	Y
Panel B. IPA/PxD1-K								
Treated	0.035	0.038*	0.096***	0.096***	1.281*	1.352*	1.622***	1.787***
	(0.022)	(0.022)	(0.025)	(0.025)	(0.188)	(0.212)	(0.204)	(0.244)
Mean Control	0.78	0.78	0.33	0.33	0.77	0.77	0.33	0.33
Observations	1471	1471	1471	1471	1435	1435	1471	1471
Add. Controls	N	Y	N	Y	N	Y	N	Y
Panel C. IPA/PxD2-K								
Treated	0.056***	0.053***	0.102***	0.094***	1.548***	1.571***	1.546***	1.574***
	(0.012)	(0.012)	(0.016)	(0.016)	(0.142)	(0.156)	(0.107)	(0.119)
Mean Control	0.81	0.81	0.45	0.45	0.81	0.81	0.45	0.45
Observations	4822	4822	4822	4822	4730	4655	4822	4777
Add. Controls	N	Y	N	Y	N	Y	N	Y
Panel D. 1AF1-K								
Treated	-0.002	0.005	0.096***	0.102***	0.990	1.029	1.515***	1.625***
	(0.026)	(0.025)	(0.031)	(0.030)	(0.159)	(0.176)	(0.204)	(0.232)
Mean Control	0.80	0.80	0.32	0.32	0.80	0.80	0.32	0.32
Observations	1087	1087	1087	1087	1087	1087	1087	1087
Add. Controls	N	Y	N	Y	N	Y	N	Y

Notes: This table reports the effect of each program on knowledge and awareness of agricultural lime. Columns (1) to (4) report effects estimated using linear probability models (LPM), and columns (5) to (8) report odds ratios (OR), estimated using logit. *Awareness (Lime)* is a dummy variable reporting whether farmers had heard about agricultural lime. *Knowledge (Acidity)* is coded as one if the farmer mentions lime as a strategy to deal with or reduce soil acidity. at endline. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are shown in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table D2: Followed Lime Recommendations

	LPM						Logit (OR)					
	Survey		Admin (all)		Admin (enroll)		Survey		Admin (all)		Admin (enroll)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. KALRO												
Treated	-0.002	-0.001	-0.011	-0.007			1.013	0.982	0.867	0.894		
	(0.020)	(0.020)	(0.022)	(0.022)			(0.282)	(0.290)	(0.218)	(0.238)		
Mean Control	0.10	0.10	0.11	0.11			0.13	0.13	0.12	0.12		
Observations	773	773	773	773			561	561	674	664		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel B. IPA/PxD1-K												
Treated	0.040**	0.039**	0.017	0.018			1.526**	1.558**	1.153	1.166		
	(0.017)	(0.017)	(0.017)	(0.017)			(0.290)	(0.311)	(0.170)	(0.172)		
Mean Control	0.22	0.22	0.24	0.24			0.22	0.22	0.25	0.25		
Observations	1471	1471	1897	1897			1393	1393	1854	1854		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel C. IPA/PxD2-K												
Treated	0.074***	0.076***	0.031***	0.030***			1.567***	1.663***	1.308***	1.379***		
	(0.013)	(0.013)	(0.010)	(0.009)			(0.131)	(0.150)	(0.116)	(0.145)		
Mean Control	0.31	0.31	0.30	0.30			0.32	0.31	0.30	0.28		
Observations	4822	4822	5890	5890			4722	4647	5732	5476		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel D. 1AF1-K												
Treated	0.050**	0.051**	0.034***	0.034***	0.058***	0.059***	1.505**	1.658**	1.379***	1.446***	1.431***	1.539***
	(0.022)	(0.021)	(0.010)	(0.009)	(0.016)	(0.014)	(0.284)	(0.338)	(0.133)	(0.149)	(0.145)	(0.167)
Mean Control	0.12	0.12	0.10	0.10	0.17	0.17	0.12	0.12	0.10	0.10	0.17	0.17
Observations	1087	1087	4884	4884	2931	2931	1087	1087	4884	4884	2931	2931
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel E. 1AF2-K												
Treated			0.024***	0.025***	0.031***	0.031***			1.150***	1.152***	1.197***	1.201***
			(0.005)	(0.005)	(0.006)	(0.006)			(0.035)	(0.035)	(0.042)	(0.043)
Mean Control			0.32	0.32	0.42	0.42			0.32	0.32	0.42	0.42
Observations			32572	32572	24825	24825			32572	32572	24623	24623
Add. Controls			N	Y	N	Y			N	Y	N	Y
Panel F. 1AF3-R												
Treated			0.006***	0.007***	0.008**	0.011***			1.174***	1.241***	1.160**	1.252***
			(0.002)	(0.002)	(0.003)	(0.003)			(0.071)	(0.067)	(0.070)	(0.068)
Mean Control			0.04	0.04	0.06	0.06			0.04	0.05	0.06	0.08
Observations			82873	82873	54052	54052			82873	57189	54052	39083
Add. Controls			N	Y	N	Y			N	Y	N	Y

Notes: This table reports the effect of each program on whether farmers followed lime recommendations. Columns (1)-(6) report effects estimated using linear probability models (LPM). Columns (7)-(12) report odds ratios (OR), estimated using logit. Columns (1)-(2) and (7)-(8) report survey results. Column (3)-(6) and (9)-(12) show results using administrative data (lime purchases or coupon redemption). Columns (5)-(6) and (11)-(12) show results for the subset of 1AF farmers registered in the 1AF input program in the concurrent season that texts were sent. In panels A and D-F the dependent variable takes value one if the farmer used or acquired agricultural lime. In panels B and C, the dependent variable takes the value one if the farmer used lime in an area where it was recommended (or would have been recommended) or did not use lime in an area where it was not recommended (or would have not been recommended). In panel A, columns (3), (4), (9), and (10), the results are measured through coupon redemption in the second season. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are shown in parentheses. In panel F, standard errors are clustered at the 1AF group level. $^{*}p < .10$, $^{**}p < .05$, $^{***}p < .01$.

Table D3: Use of Recommended Fertilizers

	LPM						Logit (OR)					
	Survey		Admin (all)		Admin (enroll)		Survey		Admin (all)		Admin (enroll)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. KALRO												
Treated	-0.030	-0.033	0.026	0.025			0.818	0.810	1.122	1.121		
	(0.029)	(0.029)	(0.035)	(0.035)			(0.151)	(0.155)	(0.174)	(0.178)		
Mean Control	0.81	0.81	0.41	0.41			0.81	0.81	0.41	0.41		
Observations	773	773	773	773			773	773	773	773		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel B. IPA/PxD1-K												
Treated	0.011	0.011	0.012*	0.011			1.091	1.079	1.725	1.706		
	(0.020)	(0.020)	(0.007)	(0.007)			(0.175)	(0.177)	(0.624)	(0.614)		
Mean Control	0.15	0.15	0.02	0.02			0.17	0.17	0.03	0.03		
Observations	1471	1471	1897	1897			1378	1373	1278	1278		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel C. IPA/PxD2-K												
Treated	0.035***	0.034***	0.004	0.005			1.294***	1.296***	1.184	1.244		
	(0.012)	(0.013)	(0.005)	(0.005)			(0.120)	(0.124)	(0.234)	(0.256)		
Mean Control	0.16	0.16	0.02	0.02			0.16	0.16	0.03	0.04		
Observations	4822	4822	5890	5890			4754	4674	4024	3471		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel D. 1AF2-K												
Treated			0.028***	0.030***	0.031***	0.033***			1.288***	1.346***	1.271***	1.349***
			(0.006)	(0.006)	(0.008)	(0.007)			(0.070)	(0.078)	(0.074)	(0.084)
Mean Control			0.14	0.14	0.19	0.19			0.14	0.14	0.19	0.19
Observations			32572	32572	24825	24825			32572	32572	24825	24825
Add. Controls			N	Y	N	Y			N	Y	N	Y

Notes: This table reports the effect of each program on the use of chemical fertilizers. Columns (1) - (6) report effects measured using linear probability models (LPM) and columns (7) - (12) report odds ratios (OR) estimated using logit. In columns (1)-(2), and (7)-(8), the dependent variables are obtained from self-reported survey data, while in columns (3)-(6) and (9)-(12) the dependent variables are measured through administrative data. In panel A, the dependent variable takes value one if the farmer used at least one type of recommended fertilizer, but administrative data is obtained from coupon redemption in the second season. In panel B and C, the dependent variable in columns (1), (2), (7), and (8) indicates whether the farmer reported using urea, while the dependent variable in columns (3), (4), (9), and (10) indicates whether they used the electronic coupon to purchase urea. In panel D, the dependent variable indicates whether the farmer purchased additional CAN from 1AF. Since only a subset of treated farmers were recommended Extra CAN, here *Treated* indicates that the farmer was assigned to the "Lime+CAN" subtreatment and the comparison is against the control group. Columns (5)-(6) and (11)-(12) show results for the administrative data for the subset of 1AF farmers registered in the input program in the concurrent season that texts were sent. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are in parentheses.* $p < .10$, ** $p < .05$, *** $p < .01$.

Table D4: Lime Recommendations: Persistence & Fatigue

	LPM						Logit (OR)					
	Survey		Admin (all)		Admin (enroll)		Survey		Admin (all)		Admin (enroll)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. KALRO												
Treated (S_t)			-0.011	-0.007					0.867	0.894		
			(0.022)	(0.022)					(0.218)	(0.238)		
Mean Control			0.11	0.11					0.12	0.12		
Observations			773	773					674	664		
Add. Controls			N	Y					N	Y		
Panel B. IPA/PxD1-K												
Treated (S_t & S_{t+1})	0.053***	0.055***	0.005	0.006			1.612***	1.676***	1.118	1.130		
	(0.019)	(0.019)	(0.010)	(0.010)			(0.274)	(0.292)	(0.271)	(0.275)		
Mean Control	0.15	0.15	0.11	0.11			0.16	0.16	0.07	0.07		
Observations	1471	1471	1897	1897			1409	1404	1531	1531		
Add. Controls	N	Y	N	Y			N	Y	N	Y		
Panel C. IPA/PxD2-K												
Treated (S_t)	0.011	0.009*					1.226	1.209				
	(0.009)	(0.005)					(0.212)	(0.215)				
Mean Control	0.22	0.22					0.20					
Observations	3227	3227					2363	2363				
Add. Controls	N	Y					N	Y^{++}				
Panel D. 1AF1-K												
Treated (S_t)			0.001	0.001	0.000	-0.004			1.017	1.000	1.002	0.960
			(0.016)	(0.016)	(0.022)	(0.021)			(0.205)	(0.207)	(0.206)	(0.201)
Treated (S_t & S_{t+1})			0.021	0.023	0.030	0.029			1.272	1.323	1.286	1.304
			(0.016)	(0.016)	(0.023)	(0.022)			(0.252)	(0.269)	(0.260)	(0.268)
Mean Control			0.09	0.09	0.12	0.12			0.09	0.09	0.12	0.12
Observations			2871	2871	1986	1986			2871	2871	1986	1986
Add. Controls			N	Y	N	Y			N	Y	N	Y
Panel E. 1AF3-R												
Treated (S_t)			0.004	0.005	0.006	0.007			1.060	1.093	1.072	1.085
			(0.004)	(0.003)	(0.006)	(0.005)			(0.065)	(0.063)	(0.067)	(0.064)
Treated (S_t & S_{t+1})			0.019***	0.018***	0.025***	0.025***			1.305***	1.349***	1.288***	1.331***
			(0.004)	(0.004)	(0.006)	(0.005)			(0.083)	(0.083)	(0.083)	(0.084)
Mean Control			0.07	0.07	0.10	0.10			0.07	0.09	0.10	0.11
Observations			51923	51923	36012	36012			51923	40628	36012	31468
Add. Controls			N	Y	N	Y			N	Y	N	Y

Notes: This table reports the effect of each program on whether farmers followed the lime recommendations during a second season. *Treated (S_t)* indicates that the farmer received text messages only in the first season (we denote this as persistence), *Treated (S_t & S_{t+1})* indicates that the farmer received text-messages in the first and second seasons (we denote this as fatigue). Columns (1)-(6) report effects estimated using linear probability models (LPM). Columns (7)–(12) report odds ratios (OR), estimated using logit. Columns (1)-(2) and (7)-(8) report results using survey data. Columns (3)-(6) and (9)-(12) show results using administrative data (lime purchases or coupon redemption). Columns (5)-(6) and (11)-(12) show results using the administrative data for the subset of 1AF farmers registered in the 1AF input program in the second season. In panels D and E, the sample is also restricted to the farmers registered for the program in the first season, as the others were not eligible to receive text messages in the second season. In panels A, D, and E the dependent variable takes value one if the farmer used or acquired agricultural lime. In panels B and C, the dependent variable takes the value of one if the farmer used lime in an area where it was recommended (or would have been recommended) or did not use lime in an area where it was not recommended (or would have not been recommended). Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. The regression in panel C column (8) includes controls but does not include area fixed effects to avoid convergence issues (Y^{++}). Robust standard errors are shown in parentheses. In panel E the standard errors are clustered at the 1AF group level. $^{*}p < .10$, $^{**}\ p < .05$, $^{***}\ p < .01$.

Table D5: Fertilizer Recommendations: Persistence

	LPM						Logit (OR)					
	Survey		Admin (all)		Admin (enroll)		Survey		Admin (all)		Admin (enroll)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. KALRO												
Treated (S_t)			0.026	0.025					1.122	1.121		
			(0.035)	(0.035)					(0.174)	(0.178)		
Mean Control			0.41	0.41					0.41	0.41		
Observations			773	773					773	773		
Add. Controls			N	Y					N	Y		
Panel B. IPA/PxD1-K												
Treated (S_t)	0.030	0.036*					1.279	1.321*				
	(0.020)	(0.020)					(0.201)	(0.213)				
Mean Control	0.17	0.17					0.18	0.18				
Observations	1471	1471					1370	1370				
Add. Controls	N	Y					N	Y				
Panel C. IPA/PxD2-K												
Treated (S_t)	-0.003	-0.002					0.962	0.994				
	(0.011)	(0.012)					(0.139)	(0.153)				
Mean Control	0.09	0.09					0.11	0.12				
Observations	3313	3313					2876	2629				
Add. Controls	N	Y					N	Y				
Panel D. 1AF2-K												
Treated (S_t)			0.007	0.009	0.009	0.011			1.073	1.086	1.064	1.086
			(0.006)	(0.006)	(0.009)	(0.009)			(0.060)	(0.063)	(0.066)	(0.071)
Mean Control			0.13	0.13	0.24	0.24			0.13	0.13	0.24	0.24
Observations			32572	32572	18356	18356			32572	32572	18356	18356
Add. Controls			N	Y	N	Y			N	Y	N	Y

Notes: This table reports the effect of each program on whether farmers followed the fertilizer recommendations during the second season. *Treated (S_t)* indicates that the farmer received text-messages only in the first season (we denote this as persistence). Columns (1)-(6) report effects estimated using linear probability models (LPM). Columns (7)-(12) report odds ratios (OR), estimated using logit. In panel A, the dependent variable takes value one if the farmer purchased at least one type of recommended fertilizer in the second season. In panels B and C, the dependent variable indicates whether the farmer reported using urea. In panel D, the dependent variable indicates whether the farmer purchased additional CAN from 1AF. Since only a subset of treated farmers were recommended extra CAN, here *Treated* indicates that the farmer was assigned to the "Lime+CAN" subtreatment and the comparison is against the control group. Columns (1)-(2) and (7)-(8) report results using survey data. Columns (3)-(6), (9)-(12) report results using administrative data (fertilizer purchases or coupon redemption). In panel D the sample is restricted to the farmers registered for the 1AF input program in the first season. Columns (5)-(6) and (11)-(12) show results using the administrative data for the subset of 1AF farmers registered in the 1AF input program in the second season. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are shown in parentheses. $^{*}p < .10$, ** $p < .05$, *** $p < .01$.

Table D6: Use of All Recommended Inputs and Other Inputs

	Recommended Inputs (index)		Other Inputs (index)		Other Fertilizers (index)	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. KALRO						
Treated	0.018	0.012	-0.021	0.000		
	(0.026)	(0.026)	(0.047)	(0.045)		
Observations	773	773	773	773		
Add. Controls	N	Y	N	Y		
Panel B. IPA/PxD1-K						
Treated	0.055*	0.054			-0.076***	-0.077***
	(0.033)	(0.033)			(0.027)	(0.027)
Observations	1471	1471			1471	1471
Add. Controls	N	Y			N	Y
Panel C. IPA/PxD2-K						
Treated	0.065***	0.059***	-0.066***	-0.056**	-0.021	-0.022
	(0.020)	(0.017)	(0.025)	(0.024)	(0.020)	(0.019)
Observations	4822	4822	4822	4822	4822	4822
Add. Controls	N^+	Y	N^+	Y	N^+	Y
Panel D. 1AF1-K						
Treated	0.102***	0.101***	0.020	0.022		
	(0.029)	(0.027)	(0.015)	(0.015)		
Observations	4884	4884	4884	4884		
Add. Controls	N	Y	N	Y		
Panel E. 1AF2-K						
Treated	0.075***	0.077***	-0.001	-0.002		
	(0.013)	(0.013)	(0.009)	(0.009)		
Observations	13014	13014	13014	13014		
Add. Controls	N	Y	N	Y		
Panel F. 1AF3-R						
Treated	0.030***	0.036***	0.008	0.003		
	(0.011)	(0.009)	(0.009)	(0.007)		
Observations	82873	82873	82873	82873		
Add. Controls	N	Y	N	Y^+		

Notes: This table presents the results of indexes of recommended inputs (columns (1) and (2)), other inputs not mentioned by the text messages (columns (3) and (4)), and other fertilizers not recommended (columns (5) and (6)). Each index is composed of different variables, depending on the project. For a full list of variables, see Table B1. The coefficients are average effect sizes. Panel F, column (4) includes fixed effect at the 1AF sector level instead of the site level to ensure standard errors can be computed (Y^+).Regressions in odd columns control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. For panel C, the strata does not include agrovet fixed effects to ensure standard errors can be computed (N^+). Robust standard errors are in parentheses. In panel F standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table D7: Quantities

	Kg Lime				Kg Fertilizer	
	Lime Rec.		Lime not Rec.			
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. KALRO						
Treated	-2.250	-1.674			1.394	1.365
	(3.688)	(3.747)			(0.906)	(0.921)
Mean Control	16.93	16.93			6.95	6.95
Observations	773	773			773	773
Add. Controls	N	Y			N	Y
Panel B. IPA/PxD1-K						
Treated	0.127	0.162	1.206	1.362	0.194	0.194
	(0.617)	(0.624)	(1.255)	(1.218)	(0.134)	(0.133)
Mean Control	2.85	2.85	3.32	3.32	0.24	0.24
Observations	1552	1552	345	345	1897	1897
Add. Controls	N	Y	N	Y	N	Y
Panel C. IPA/PxD2-K						
Treated	0.867*	0.966**	-1.558**	-1.495*	0.082	0.127
	(0.445)	(0.444)	(0.758)	(0.768)	(0.148)	(0.138)
Mean Control	3.52	3.52	3.56	3.56	0.55	0.55
Observations	4512	4512	1378	1378	5890	5890
Add. Controls	N	Y	N	Y	N	Y
Panel D. 1AF1-K						
Treated	3.592***	3.654***				
	(0.821)	(0.811)				
Mean Control	5.82	5.82				
Observations	4884	4884				
Add. Controls	N	Y				
Panel E. 1AF2-K						
Treated	2.179***	2.155***			1.495***	1.097***
	(0.453)	(0.446)			(0.465)	(0.407)
Mean Control	17.05	17.05			27.13	27.13
Observations	32572	32572			32555	32555
Add. Controls	N	Y			N	Y
Panel F. 1AF3-R						
Treated	0.117	0.177				
	(0.146)	(0.125)				
Mean Control	1.79	1.79				
Observations	82873	82873				
Add. Controls	N	Y				

Notes: The table reports the effects of the programs on the unconditional quantity of lime and fertilizer purchased, expressed in kgs. In panel A, columns (5) and (6), the dependent variable indicates the total quantity of fertilizer purchased (planting and top-dressing). In panels B and C, columns (1)-(2) and (3)-(4), the sample is divided based on whether lime was recommended in the farmer's area (Lime Rec) or not (Lime not Rec), while in columns (5) and (6) the dependent variable indicates the quantity of urea purchased using the electronic coupons. In panel E, columns (5)-(6), the dependent variable indicates the quantity of CAN purchased from 1AF. Since only a subset of treated farmers were recommended Extra CAN, here *Treated* indicates that the farmer was assigned to the "Lime+CAN" subtreatment and the comparison is against the control group. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are in parentheses. In panel E, the standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table D8: Spillovers

	LPM								Logit (OR)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. 1AF1-K, Lime recommendations																
N treated	-0.009	-0.000							0.913	1.006						
	(0.007)	(0.006)							(0.063)	(0.069)						
Mean	0.10	0.10							0.10	0.11						
Sample	Control	Control							Control	Control						
Observations	1559	1559							1559	1453						
Add. Controls	N	Y							N	Y						
Panel B. 1AF2-K, Lime recommendations																
N treated	0.006	0.006							1.036	1.037						
	(0.004)	(0.004)							(0.023)	(0.023)						
Mean	0.32	0.32							0.33	0.33						
Sample	Control	Control							Control	Control						
Observations	8142	8142							7966	7956						
Add. Controls	N	Y							N	Y						
Panel C. 1AF2-K, Fertilizer recommendations																
N treated	0.003	0.004							1.025	1.036						
	(0.004)	(0.003)							(0.033)	(0.035)						
Mean	0.14	0.14							0.15	0.15						
Sample	Control	Control							Control	Control						
Observations	8142	8142							7843	7843						
Add. Controls	N	Y							N	Y						
Panel D. 1AF3-R, Lime recommendations																
N treated	0.001	0.000					0.002***	0.000	1.018	0.996					1.092***	1.015
	(0.001)	(0.001)					(0.000)	(0.000)	(0.019)	(0.023)					(0.012)	(0.012)
Group Treated			0.002	0.004**	0.002	0.003**					1.052	1.135**	1.145	1.167*		
			(0.002)	(0.002)	(0.001)	(0.001)					(0.070)	(0.069)	(0.099)	(0.095)		
Mean	0.04	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.04	0.07	0.04	0.06	0.02	0.03	0.02	0.03
Sample	Part. C.	Part. C.	Part. & Full C.	Part. & Full C.	All	All	All	All	Part. C.	Part. C.	Part. & Full C.	Part. & Full C.	All	All	All	All
Has Phone	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	No	No	No	No
Observations	27527	27527	46593	46593	92572	92572	92572	92572	27527	13769	46593	27401	92572	55397	92572	55397
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: This table reports spillover effects within 1AF farmer groups. Columns (1)-(8) report effects measured using linear probability models (LPM), and columns (9)-(16) report odds ratios (OR) estimated using logit. In panels A, B, and D, the dependent variable in the column indicates whether farmers purchased lime from 1AF. In panel C, the dependent variable in the column indicates whether farmers purchased the recommended fertilizer from 1AF. *N treated* indicates the number of treated farmers in the 1AF group, *Group Treated* is a dummy equal to 1 if some farmers in the group were assigned to be treated. The sample in panels A to C, is restricted to farmers who were not assigned to receive messages (control). In panel C, a sample that indicates 'Part. C. ' denotes that only those farmers randomized to remain as controls in partly treated groups are included in the regressions. 'Part. & Full C. ' denotes that only farmers assigned to control partially treated groups and those in the groups where no one was treated are included in the regressions. Has Phone 'Y' denotes farmers that reported having a phone line at baseline. Has phone 'N' uses only the sample of farmers that do not report having a phone line at baseline. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are in parentheses; in panel C, standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

E Pooled Regressions

Table E1: Pooled Regressions

	LPM		Logit (OR)	
	Lime (1)	Fertilizer (2)	Lime (3)	Fertilizer (4)
Treated	0.013	0.012	1.143	1.115
	(0.002)***	(0.003)***	(0.021)**	(0.040)**
	⟨0.006⟩	⟨0.002⟩	⟨0.022⟩	⟨0.010⟩
	[0.031]	[0.000]	[0.031]	[0.000]
Mean Control	0.131	0.128	0.131	0.128
Observations	31,253	10,628	128,889	41,132

Notes: This table shows the effect of the programs on following lime and fertilizer recommendations, pooling data from all programs. Both dependent variables are measured using administrative data for the first season, except for KALRO, where administrative data for the second season is used. All regressions include program FEs. Columns (1)-(2) report estimating using linear probability models (LPM), columns (3)-(4) report odds (OR) ratios estimated using logit. Bootstrap standard errors are shown in parentheses. We also show very conservative standard errors clustered at the experiment level in angled brackets and wild cluster bootstrap-adjusted p-values for the low number of clusters in square brackets.* $p < .10$, ** $p < .05$, *** $p < .01$.

Table E2: Heterogeneity (Pooled Specifications)

	LPM						Logit (OR)					
	Female (1)	Primary (2)	Large Farm (3)	Young (4)	Used Input (5)	Heard Input (6)	Female (7)	Primary (8)	Large Farm (9)	Young (10)	Used Input (11)	Heard Input (12)
Panel A. Followed Lime Recommendations												
Treated	0.033***	0.018	0.013***	0.022***	0.007***	0.015	1.183***	1.115	1.146***	1.101***	1.162***	1.078
	(0.007)	(0.015)	(0.002)	(0.007)	(0.001)	(0.011)	(0.052)	(0.084)	(0.030)	(0.028)	(0.034)	(0.070)
$[X]$	-0.028	0.055*	0.016	0.003	-0.054	-0.039	0.729	1.979**	1.204	1.066	0.520	0.715
	(0.026)	(0.029)	(0.019)	(0.020)	(0.035)	(0.025)	(0.213)	(0.556)	(0.297)	(0.208)	(0.325)	(0.177)
$[X]$ *Treated	-0.010	0.013	0.000	0.008	0.014	0.039**	0.938	1.055	0.994	1.055	1.020	1.245*
	(0.010)	(0.020)	(0.004)	(0.009)	(0.010)	(0.020)	(0.052)	(0.108)	(0.041)	(0.058)	(0.086)	(0.155)
Mean Control	0.29	0.23	0.13	0.31	0.06	0.25	0.29	0.23	0.13	0.31	0.06	0.25
Observations	44969	9711	128889	40164	91433	8560	44969	9711	128889	40164	91433	8560
Panel B. Followed Fertilizer Recommendations												
Treated	0.100*	0.206	0.099***	0.091**	0.117**	0.359	1.105	1.228	1.104***	1.095**	1.124**	1.432
	(0.058)	(0.180)	(0.034)	(0.042)	(0.053)	(0.448)	(0.069)	(0.212)	(0.038)	(0.043)	(0.052)	(0.688)
$[X]$	0.146	0.399**	-0.305**	0.043	-0.027	0.053	1.157	1.491**	0.737*	1.044	0.973	1.054
	(0.141)	(0.199)	(0.149)	(0.158)	(0.152)	(0.356)	(0.207)	(0.291)	(0.119)	(0.141)	(0.147)	(0.363)
$[X]$ *Treated	0.013	-0.067	0.040	0.060	0.060	-0.286	1.013	0.935	1.041	1.062	1.062	0.751
	(0.068)	(0.212)	(0.077)	(0.082)	(0.077)	(0.436)	(0.070)	(0.210)	(0.071)	(0.082)	(0.081)	(0.380)
Mean Control	0.13	0.08	0.13	0.13	0.13	0.41	0.13	0.08	0.13	0.13	0.13	0.41
Observations	40157	8560	41132	40164	41132	773	40157	8560	41132	40164	41132	773

Notes: This table shows results of heterogeneity analysis pooling data from different programs. The dependent variable is whether the farmer followed lime recommendations (panel A) or fertilizer recommendations (panel B) in the first season. Both dependent variables are measured using administrative data for the first season except for KALRO, where administrative data for the second season is used. The analysis depends on the availability of data. In Panel A, this includes: respondent's gender (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF1-K, 1AF2-K), whether respondent completed primary school (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF1-K), whether the respondent's land is 'large' -defined as above median use of inputs for the 1AF samples and more than 1.5 acres of land for the other programs- (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF1-K, 1AF2-K, 1AF3-K), whether the respondent was under 40 years old (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF2-K), whether the respondent had previously used the input (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF3-R), and whether the respondent had previous knowledge of the input or was aware of it (KALRO, PxD/IPA1-K, PxD/IPA2-K). In Panel B, this respondent's gender (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF2-K), whether respondent completed primary school (KALRO, PxD/IPA1-K,PxD/IPA2-K), whether the respondent's land is 'large' (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF2-K), whether the respondent was under 40 years old (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF2-K), whether the respondent had previously used the input (KALRO, PxD/IPA1-K,PxD/IPA2-K, 1AF2-K), and whether the respondent had previous knowledge of the input (KALRO). All regressions include program FEs. Columns (1)-(6) report effects estimated using linear probability models (LPM), and columns (7)-(12) report odds ratios (OR) estimated using logit. Bootstrap standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

F Results by Experiment: By Treatment Arms

Table F1: Knowledge and Use by Treatment Arms

	LPM								Logit (OR)							
	Awareness (Lime)		Knowledge (Lime)		Followed Lime Rec		Purchased Fertilizer		Awareness (Lime)		Knowledge (Lime)		Followed Lime Rec		Purchased Fertilizer	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A. IPA/PxD1-K																
General	0.036	0.039	0.066**	0.068**	0.019	0.020	0.013	0.013	1.300	1.348	1.403**	1.555***	1.168	1.189	1.820	1.801
	(0.025)	(0.025)	(0.029)	(0.028)	(0.020)	(0.020)	(0.009)	(0.008)	(0.223)	(0.248)	(0.202)	(0.242)	(0.201)	(0.206)	(0.732)	(0.716)
Specific	0.035	0.037	0.127***	0.123***	0.016	0.016	0.010	0.010	1.261	1.356*	1.871***	2.039***	1.138	1.144	1.634	1.616
	(0.025)	(0.025)	(0.030)	(0.029)	(0.019)	(0.019)	(0.008)	(0.008)	(0.215)	(0.247)	(0.270)	(0.318)	(0.189)	(0.190)	(0.654)	(0.651)
Mean Control	0.78	0.78	0.33	0.33	0.24	0.24	0.02	0.02	0.77	0.77	0.33	0.33	0.25	0.25	0.03	0.03
Observations	1471	1471	1471	1471	1897	1897	1897	1897	1435	1435	1471	1471	1854	1854	1278	1278
p-value General=Specific	0.956	0.945	0.046	0.059	0.901	0.857	0.770	0.779	0.866	0.976	0.042	0.070	0.875	0.816	0.756	0.757
Panel B. IPA/PxD2-K																
SMS	0.043***	0.043***	0.092***	0.085***	0.029**	0.030***	0.006	0.007	1.381***	1.405***	1.482***	1.507***	1.279**	1.390***	1.279	1.331
	(0.015)	(0.015)	(0.020)	(0.019)	(0.013)	(0.012)	(0.006)	(0.006)	(0.157)	(0.173)	(0.126)	(0.138)	(0.137)	(0.172)	(0.300)	(0.322)
SMS + Call	0.069***	0.068***	0.118***	0.114***	0.022*	0.020*	0.009	0.010*	1.763***	1.830***	1.660***	1.738***	1.213*	1.247*	1.407	1.519*
	(0.014)	(0.014)	(0.020)	(0.019)	(0.013)	(0.012)	(0.006)	(0.006)	(0.208)	(0.232)	(0.142)	(0.161)	(0.132)	(0.162)	(0.327)	(0.368)
SMS + Call Offer	0.055***	0.048***	0.096***	0.082***	0.043***	0.039***	-0.003	-0.002	1.542***	1.531***	1.504***	1.491***	1.438***	1.507***	0.877	0.899
	(0.015)	(0.015)	(0.020)	(0.020)	(0.013)	(0.012)	(0.005)	(0.005)	(0.180)	(0.192)	(0.128)	(0.139)	(0.154)	(0.187)	(0.225)	(0.239)
Mean Control	0.81	0.81	0.45	0.45	0.30	0.30	0.02	0.02	0.81	0.81	0.45	0.45	0.30	0.28	0.03	0.04
Observations	4822	4822	4822	4822	5890	5890	5890	5890	4730	4655	4822	4777	5732	5476	4024	3471
p-value SMS=SMS+Call	0.053	0.063	0.190	0.130	0.616	0.369	0.686	0.573	0.046	0.046	0.182	0.115	0.617	0.373	0.668	0.565
p-value SMS=SMS+Call Offer	0.391	0.711	0.859	0.856	0.267	0.474	0.123	0.134	0.363	0.510	0.865	0.907	0.263	0.484	0.125	0.118
p-value SMS+Call=SMS+Call Offer	0.287	0.135	0.257	0.093	0.109	0.107	0.056	0.040	0.285	0.184	0.244	0.096	0.109	0.117	0.054	0.039
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel C. 1AF1-K																
Broad	0.002	0.011	0.084**	0.094***	0.029**	0.029***			1.010	1.067	1.440**	1.572***	1.321**	1.382***		
	(0.029)	(0.029)	(0.035)	(0.035)	(0.011)	(0.011)			(0.187)	(0.211)	(0.222)	(0.259)	(0.145)	(0.161)		
Detailed	-0.005	-0.001	0.109***	0.110***	0.039***	0.039***			0.969	0.991	1.597***	1.680***	1.439***	1.512***		
	(0.030)	(0.029)	(0.036)	(0.035)	(0.012)	(0.011)			(0.180)	(0.198)	(0.248)	(0.274)	(0.156)	(0.177)		
Mean Control	0.80	0.80	0.32	0.32	0.10	0.10			0.80	0.80	0.32	0.32	0.10	0.10		
Observations	1087	1087	1087	1087	4884	4884			1087	1087	1087	1087	4884	4884		
p-value Broad=Detailed	0.822	0.692	0.492	0.655	0.395	0.391			0.822	0.717	0.491	0.679	0.395	0.410		
Add. Controls	N	Y	N	Y	N	Y			N	Y	N	Y	N	Y		
Panel D. 1AF2-K																
Lime only					0.022***	0.023***	0.009**	0.009**					1.137***	1.140***	1.087**	1.102**
					(0.005)	(0.005)	(0.004)	(0.004)					(0.036)	(0.036)	(0.045)	(0.048)
Lime+CAN					0.033***	0.032***	0.028***	0.030***					1.204***	1.203***	1.288***	1.346***
					(0.008)	(0.008)	(0.006)	(0.006)					(0.052)	(0.052)	(0.070)	(0.078)
Mean Control					0.32	0.32	0.14	0.14					0.32	0.32	0.14	0.14
Observations					32572	32572	32572	32572					32572	32572	32572	32572
p-value Lime only=Lime+CAN					0.135	0.164	0.000	0.000					0.130	0.163	0.000	0.000
Add. Controls					N	Y	N	Y					N	Y	N	Y
Panel E. 1AF3-R																
Full treatment					0.006**	0.007***							1.163**	1.234***		
					(0.002)	(0.002)							(0.077)	(0.073)		
Partial treatment: treated					0.006***	0.007***							1.188***	1.251***		
					(0.002)	(0.002)							(0.078)	(0.075)		
Mean Control					0.04	0.04							0.04	0.05		
Observations					82873	82873							82873	57189		
p-value Full treat=Partial treat					0.685	0.781							0.685	0.769		
Add. Controls					N	Y							N	Y		

Notes: The table shows effects by treatment arms on awareness, knowledge, and the probability of following the recommendations. Columns (1)-(8) report effects estimated using linear probability models (LPM), and columns (9)-(16) report odds ratios (OR) estimated using logit. The dependent variable in columns (1)-(2) and (9)-(10) is a dummy variable reporting whether farmers had heard about agricultural lime at endline. The dependent variable in columns (3)-(4) and (11)-(12) is coded as one if the farmer mentions lime as a strategy to deal with or reduce soil acidity. The dependent variable in columns (5)-(6) and (13)-(14) indicates whether farmers followed lime recommendations, measured using administrative data. In panels A and B, it takes value one if the farmer used lime and lime was recommended (or would have been recommended) or if the farmer did not use lime and lime was not recommended (or would have not been recommended), zero otherwise. In panels C-E takes value one if the farmer purchased lime, zero otherwise. The dependent variable in columns (7)-(8) and (15)-(16) indicates whether farmers followed the fertilizer recommendations, measured using administrative data. Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are in parentheses. In panel E the standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table F2: Message Framing

	LPM						Logit (OR)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. 1AF2-K, Lime												
Basic	0.017**	0.018**					1.104**	1.109**				
	(0.008)	(0.008)					(0.050)	(0.051)				
Yield Increase	0.034***	0.034***	0.016*	0.016*			1.211***	1.216***	1.096*	1.095*		
	(0.008)	(0.008)	(0.009)	(0.009)			(0.055)	(0.056)	(0.057)	(0.057)		
Experimentation (self)	0.027***	0.027***	0.010	0.009			1.167***	1.169***	1.057	1.053		
	(0.008)	(0.008)	(0.009)	(0.009)			(0.053)	(0.054)	(0.055)	(0.055)		
Experimentation (neighbors)	0.013	0.013	-0.004	-0.005			1.075	1.078	0.973	0.972		
	(0.008)	(0.008)	(0.009)	(0.009)			(0.050)	(0.050)	(0.051)	(0.051)		
Social Compasion	0.028***	0.028***	0.011	0.010			1.176***	1.173***	1.064	1.056		
	(0.008)	(0.008)	(0.009)	(0.009)			(0.054)	(0.054)	(0.056)	(0.056)		
Self-efficacy	0.028***	0.028***	0.011	0.010			1.173***	1.175***	1.062	1.059		
	(0.008)	(0.008)	(0.009)	(0.009)			(0.054)	(0.054)	(0.055)	(0.056)		
Family framed SMS					-0.016***	-0.016***					0.912***	0.912***
					(0.005)	(0.005)					(0.028)	(0.028)
Mean Control	0.32	0.32			.	.	0.32	0.32				
F test p-value			0.22	0.24					0.21	0.23		
Observations	32572	32572	24430	24430	24430	24430	32572	32572	24430	24430	24430	24430
Includes Control Group	Y	Y	N	N	Y	Y	Y	Y	N	N	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel B. 1AF2-K, Fertilizer												
Basic	0.020*	0.026**					1.215*	1.298**				
	(0.012)	(0.012)					(0.131)	(0.147)				
Yield Increase	0.014	0.020*	-0.007	-0.006			1.138	1.201	0.932	0.927		
	(0.012)	(0.012)	(0.017)	(0.016)			(0.128)	(0.145)	(0.139)	(0.147)		
Experimentation (self)	0.034***	0.036***	0.013	0.010			1.362***	1.416***	1.118	1.095		
	(0.013)	(0.012)	(0.017)	(0.016)			(0.145)	(0.162)	(0.161)	(0.168)		
Experimentation (neighbors)	0.025*	0.028**	0.004	0.002			1.266**	1.331**	1.038	1.028		
	(0.013)	(0.012)	(0.017)	(0.016)			(0.141)	(0.157)	(0.154)	(0.161)		
Social Compasion	0.051***	0.043***	0.031*	0.018			1.544***	1.529***	1.271*	1.185		
	(0.013)	(0.013)	(0.017)	(0.016)			(0.162)	(0.169)	(0.182)	(0.179)		
Self-efficacy	0.021*	0.026**	0.000	0.000			1.209*	1.296**	0.989	0.995		
	(0.012)	(0.012)	(0.017)	(0.016)			(0.135)	(0.151)	(0.147)	(0.155)		
Family framed SMS					-0.009	-0.009					0.934	0.924
					(0.010)	(0.009)					(0.079)	(0.083)
Mean Control	0.14	0.14					0.14	0.14				
F test p-value			0.33	0.75					0.32	0.69		
Observations	32572	32572	24430	24430	24430	24430	32572	32572	24344	24344	24344	24344
Includes Control Group	Y	Y	N	N	N	N	Y	Y	N	N	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel C. 1AF3-R, Lime												
General promotion	0.006**	0.007***					1.180**	1.256***				
	(0.003)	(0.003)					(0.096)	(0.095)				
Specific + yield impact	0.005	0.007***	-0.002	-0.000			1.133	1.242***	0.960	0.992		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.091)	(0.095)	(0.079)	(0.081)		
Self-diagnosis	0.009***	0.009***	0.003	0.002			1.262***	1.321***	1.070	1.049		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.101)	(0.099)	(0.088)	(0.084)		
Soil test	0.005	0.007**	-0.002	-0.001			1.134	1.232***	0.961	0.986		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.092)	(0.097)	(0.080)	(0.081)		
How travertine works	0.005*	0.006**	-0.001	-0.001			1.159*	1.202**	0.982	0.957		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.099)	(0.092)	(0.086)	(0.079)		
Order immediately	0.006**	0.007**	0.000	-0.001			1.188**	1.244***	1.007	0.986		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.097)	(0.097)	(0.084)	(0.081)		
Your cell is acidic + yield impact	0.006*	0.006**	-0.001	-0.001			1.165*	1.196**	0.987	0.954		
	(0.003)	(0.003)	(0.003)	(0.003)			(0.096)	(0.092)	(0.084)	(0.078)		
Message framed as a gain					0.004**	0.001					1.094**	1.044
					(0.002)	(0.002)					(0.049)	(0.047)
Mean Control	0.04	0.04					0.04	0.05				
F test p-value			0.88	0.96					0.87	0.93		
Observations	82873	82873	63807	63807	63807	63807	82873	57189	63807	42052	63807	42052
Includes Control Group	Y	Y	N	N	N	N	Y	Y	N	N	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: The table shows the effect of different message framings on input acquisitions. In panel A and C the dependent variable indicates whether farmers purchased lime from 1AF. In panel B the dependent variable indicates whether farmers purchased the recommended fertilizer from 1AF. Columns (1) - (6) report effects estimated using linear probability models (LPM), and columns (7) - (12) report odds ratios (OR) estimated using logit. In columns (1)-(2) and (7)-(8) the reference group is the control, in (3)-(4) and (9)-(10) is the basic or general promotion message. Columns (5)-(6) and (11)-(12) compare family framed texts against individually framed texts (panels A and B), or texts framed as a yield gain against texts framed as a yield loss (panel C). Regressions in odd columns only control for randomization strata (if used); regressions in even columns include additional controls and area-fixed effects. Robust standard errors are in parentheses. In panel C the standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table F3: Number of Messages

	LPM						Logit (OR)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. 1AF2-K, Lime												
N Lime SMS	0.004***	0.004***					1.026***	1.026***				
	(0.001)	(0.001)					(0.005)	(0.005)				
N Lime SMS≥ 1			-0.002	-0.003					0.986	0.982		
			(0.012)	(0.012)					(0.068)	(0.068)		
N Lime SMS ≥ 2			0.024*	0.025**	0.024*	0.025**			1.148*	1.158**	1.146*	1.156**
			(0.012)	(0.012)	(0.012)	(0.012)			(0.081)	(0.083)	(0.081)	(0.082)
N Lime SMS ≥ 3			0.005	0.004	0.005	0.004			1.029	1.024	1.029	1.024
			(0.008)	(0.008)	(0.008)	(0.008)			(0.046)	(0.046)	(0.045)	(0.045)
N Lime SMS ≥ 4			0.003	0.004	0.003	0.004			1.019	1.022	1.019	1.022
			(0.008)	(0.008)	(0.008)	(0.008)			(0.045)	(0.045)	(0.045)	(0.045)
N Lime SMS = 5			-0.005	-0.004	-0.005	-0.004			0.975	0.974	0.975	0.975
			(0.008)	(0.008)	(0.008)	(0.008)			(0.043)	(0.044)	(0.043)	(0.043)
Mean Control	0.32	0.32	0.32	0.32			0.32	0.32	0.32	0.32		
Observations	32572	32572	32572	32572	24430	24430	32572	32572	32572	32572	24430	24430
Includes Control Group	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel B. 1AF2-K, Fertilizer												
N Fert SMS	0.007***	0.008***					1.068***	1.078***				
	(0.002)	(0.002)					(0.015)	(0.016)				
N Fert SMS≥ 1			0.020	0.021					1.183	1.178		
			(0.023)	(0.022)					(0.226)	(0.246)		
N Fert SMS ≥ 2			-0.005	-0.001	-0.005	-0.001			0.976	1.049	0.974	1.049
			(0.024)	(0.023)	(0.024)	(0.023)			(0.203)	(0.237)	(0.204)	(0.241)
N Fert SMS ≥ 3			0.024*	0.021	0.025*	0.022			1.224*	1.206	1.236*	1.228
			(0.014)	(0.014)	(0.014)	(0.014)			(0.150)	(0.157)	(0.152)	(0.161)
N Fert SMS ≥ 4			-0.009	-0.010	-0.010	-0.010			0.931	0.925	0.926	0.915
			(0.015)	(0.014)	(0.015)	(0.014)			(0.114)	(0.120)	(0.114)	(0.119)
N Fert SMS = 5			-0.001	-0.003	-0.001	-0.002			0.981	0.957	0.987	0.971
			(0.014)	(0.014)	(0.015)	(0.014)			(0.121)	(0.123)	(0.122)	(0.126)
Mean Control	0.14	0.14	0.14	0.14			0.14	0.14	0.14	0.14		
Observations	32572	32572	32572	32572	24430	24430	32572	32572	32572	32572	24344	24344
Includes Control Group	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Panel C. 1AF3-R, Lime												
N Lime SMS	0.002***	0.002***					1.053***	1.071***				
	(0.001)	(0.000)					(0.015)	(0.015)				
N Lime SMS≥ 1			0.002	0.003					1.056	1.103		
			(0.002)	(0.002)					(0.074)	(0.073)		
N Lime SMS ≥ 2			0.005**	0.005**	0.005**	0.005**			1.150**	1.155**	1.150**	1.153**
			(0.002)	(0.002)	(0.002)	(0.002)			(0.065)	(0.070)	(0.065)	(0.070)
N Lime SMS ≥ 3			0.000	-0.000	0.000	-0.000			1.005	1.002	1.005	1.000
			(0.002)	(0.002)	(0.002)	(0.002)			(0.055)	(0.059)	(0.055)	(0.059)
N Lime SMS ≥ 4			-0.000	0.001	-0.000	0.001			0.988	1.029	0.988	1.031
			(0.002)	(0.002)	(0.002)	(0.002)			(0.055)	(0.061)	(0.055)	(0.061)
Mean Control	0.04	.	0.04	0.04			0.04	0.05	0.04	0.05		
Observations	82873	82873	82873	82873	63807	63807	82873	57189	82873	57189	63807	42052
Includes Control Group	Y	Y	Y	Y	N	N	Y	Y	Y	Y	N	N
Add. Controls	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: The table shows the effect of the number of messages on input acquisitions. In panel A and C the dependent variable indicates whether farmers purchased lime from 1AF. In panel B the dependent variable indicates whether farmers purchased the recommended fertilizer from 1AF. Columns (1)-(6) report effects estimated using linear probability models (LPM), and columns (7)-(12) report odds ratios (OR) estimated using logit. In columns (1)-(2) and (7)-(8) the independent variable is the number of text messages. In columns (3)-(4) and (9)-(10) the regressions include dummy variables for receiving [X] or more messages, and the reference group is the control. In columns (5)-(6) and (11)-(12) the reference group is receiving one message. Robust standard errors are in parentheses. In panel C the standard errors are clustered at the 1AF group level. * $p < .10$, ** $p < .05$, *** $p < .01$.

G Cost-Benefit and Cost-Effectiveness

This section provides more details for the cost-effectiveness and cost-benefit analyses.

G.1 Cost-effectiveness

For cost-effectiveness, we compare a representative program that sends three lime text messages against an in-person event that recommended lime (FFDs), and the use of incentives to sales agents to encourage lime sales. We only consider marginal costs when making comparisons, though we note that the fixed costs of operating these in-person programs are likely higher than those of the the digital program.

A summary of the numbers used for these calculations are reported in Table G1. We also provide other program details in this section.

Table G1: Cost-Effectiveness Analysis Summary

Program	Effect	Cost Per affected farmer (US$)	Per use of 10kgs of lime (US$)
Text-message			
Adoption (OR)	1.19	1.50	
Adoption (LPM)	0.02	1.50	
Quantity (kg)	1.18		0.25
KALRO's FFD			
Adoption (OR)	1.54	37.68	
Adoption (LPM)	0.04	45.61	
Quantity (kg)	6.16		2.81
1AF sales incentives			
Adoption (LPM)	0.13	1.88	
Quantity (kg)	6.60		0.38

Notes: Adoption denotes following the recommendations as measured by input purchases or coupon redemption. OR stands for odds ratios, LPM stands for linear probability model. FFD stands for farmer field days.

Text-Message program. Program effects in terms of lime use are taken from the meta-analysis results presented in Table 3. We assume a conservative marginal cost of $0.03 per farmer, for a 3-message program at a price of $0.01 per message. To estimate cost-effectiveness, we convert the estimated coefficients into the number of farmers that were induced to use lime because the program ('affected' farmers). For completeness, we estimate numbers using both our preferred summary effect in terms of odds ratios and the summary effect in terms of percentage points.

To estimate the affected number of farmers using results from linear probability models, we multiply the estimated summary effect of two percentage points by an estimate of the total number of farmers treated across projects (97,631). We estimate that 1,953 farmers were 'affected' by the program and calculate a total cost of $2,929. Dividing the total costs by the number of affected farmers, we arrive at a cost of $1.50 per affected farmer.

When using effects expressed as an odds ratio, we follow a similar approach. However, we have to account for non-linear transformations since the predicted effect is non-normal (odds ratios are log-normal). To do this, we draw a simulated sample of 1,000 observations from the predictive distribution of the log(OR). We perform subsequent operations with this simulated sample. To calculate the corresponding change in the probability of following the recommendations, we use the pooled control group lime adoption rate of 13% (Appendix Table E1). We then multiply the difference in adoption probabilities by the total number of treated farmers and divide total costs by this number. To arrive at a single per farmer cost estimate, we average over this output. We also estimate a per affected farmer cost of $1.50 (Table G1). [1]

To express costs in terms of use of 1 kg of lime, we take into account the overall amount of lime that would have been purchased because of the programs (estimated multiplying the meta-analytic effect of 1.18 kgs by the total number of treated farmers). We then divide the total cost of this representative program by this quantity.

Farmer Field Days. The effect of Farmer Field Days on the purchases of lime are obtained from Fabregas, Kremer and Schilbach (2023). To arrive to the cost estimates, we use KALRO's reported costs for administering each event ($2,600) which hosted between 100-300 farmers. This includes only the marginal costs per event, such as transport to the site, compensation to

[1] In these calculations, the control group adoption rate can influence these estimates. For example, the cost per affected farmer varies significantly, being higher at very low or very high levels of adoption (e.g., $3.5 at a control adoption rate of 0.05 and $20 at an adoption rate of 0.99). Conversely, at a baseline adoption rate of 0.5, the cost is much lower at $0.72.

facilitators, materials, labor and inputs to set up experimental plots, and invitations to other presenters (e.g. local decision-makers and input sellers). This is a cost of at least $8.6 per attending farmer. For comparison, in India, farmer field days organized by an NGO were estimated to cost approximately $5 per farmer (Emerick and Dar, 2021). However, given that the FFDs covered various agricultural topics, not only lime, we conservatively attribute 1/5 of their cost ($520) to lime teaching. Using the best case scenario for the number of farmers who attended FFDs (300) multiplied by the estimated increase in lime use (3.8 percentage points), we estimate that 11.4 farmers were induced to experiment with lime by each FFD. Therefore, we estimate a cost of $46-38 per affected farmer when using percentage point differences or odds ratios, respectively. Similarly, we estimate a cost of $2.8 per 10kg of lime used.

1AF Lime Incentive Program. Estimated effects of this program were shared by 1AF (1AF, 2019). The program was randomized among selected sites in western Kenya (this did not overlap with our sample) and targeted approximately 5,727 farmers. As part of this program, 1AF field officers could receive a payment of $0.5 per lime-adopting farmer. The program increased lime sales by 13.4 percentage points, and we estimate that approximately 767 farmers were induced by the program to experiment with lime. Accounting for the incentive for all adopting farmers ($\sim$ 885) and additional costs related to the seasonal implementation of the program, which includes some brief training for field officers, and proportional compensation for transport and additional time on lime sales, we estimate that the total cost of running the program for the season was around $1,443. Converting this to costs per 'affected' farmer we arrive at $1.88 and a cost of $0.38 per induced use of 10 kgs of lime.

G.2 Cost-benefit

For a program only focused on lime messages (3 messages total), we estimate a marginal benefit-cost ratio of around 8-to-1 for a single agricultural season (or 83-to-1 with low-cost bulk texting). To get at this number, we first estimate the benefits of using 1 kg of lime on yields. We use information from four agronomic studies of experimental maize plots in western Kenya that tested the effects of lime micro-dosing (microdosing roughly corresponds

Table G2: Cost-Benefit Analysis Parameters

	Lime	Fertilizer	Overall
Benefits			
Program impact on application (kg) (Table 3)	1.18	0.43	
Impact of 1 kg of input on yields (kg)	1.03	2.48	
Cost per 1 kg of input (US$)	0.16	0.74	
Profit from additional kg of input (US$)	0.21	0.15	
Profit per treated farmer (US$)	0.25	0.07	0.32
Program Costs			
Number of text messages	3	4	7
Cost per text message - program (US$)			0.01
Cost per text message - at scale (US$)			0.001
Marginal Benefit-Cost Ratio			
Program, as implemented	8.33	1.75	4.57
At scale	83.33	17.50	45.71

Notes: The impact of 1 kg of application on input on yield is estimated based on information available in the agronomic literature for micro-dosing lime in the region. The number of text messages is the number of topic-specific messages received by treated farmers.

to 0.5 t/ha of lime or less). The median impact on maize yields per 10 kg of lime was 10.3 kg.[2]

To get the profit from one additional kg of maize, we use average maize market prices in western Kenya from a survey of local maize dealers conducted between June 2016 and April 2017 by IPA, and subtract potential additional transport costs. We estimate gains of $0.36 per additional kg of maize harvested. The average price of lime per kg ($0.13) was taken from a survey of agricultural supply dealers in the area conducted by IPA in 2018. In addition, we assume that there are transport and other labor costs associated with using this input, which we price at $0.03 per kg. Overall, this would suggest that the average profit from using 1 kg of lime is $0.21 and the average dollar benefit as a result of the intervention (using the meta-analytic impact of 1.18 kgs) is $0.25. Comparing this to the marginal cost of the messages (either $0.03 or $0.003 at scale) we arrive at 8:1 or 83:1.

We also consider much more conservative estimates of the returns to lime. Assume, for instance, that only 80% of farmers would have, on average, a positive effect on yields, while the rest would get no change in yields from using this input (but they would still incur the

[2]This includes median effects of 18 kgs and 10.7 kg for two separate 1AF trials (1AF, 2014, 2015). An impact of 2 kg from plots in western Kenya (Kisinyo et al., 2015), and an impact of 10 kg estimated in Kenya (Omenyo, Okalebo and Othieno, 2018). Note that this estimate is more conservative than the one reported in Figure K2 since we opt to combine results from several agronomic studies in the region.

costs of liming). This is a conservative assumption, given that the estimates on the returns to lime that we use were taken from plots with heterogeneous pH levels. However, even in this case, we estimate that the benefit-to-cost ratio at scale would be 54:1. Imputing non-zero average maize revenue to only 70% or 50% of farmers, we would get at-scale marginal benefit-cost ratios of 39:1 and 10:1.

Now, take a 4-message program for fertilizer. To get the benefits of using fertilizer, we use estimates from Duflo, Kremer and Robinson (2008). They estimate a maize yield increase of 2.48 per kg of fertilizer used. Of course, this is an imperfect estimate since several different fertilizers were recommended as part of these programs, and returns might differ, but we take this as a reasonable benchmark of effects. At the time, we estimate that the average price per kg of fertilizer was $0.74. Our profit estimate per treated farmer is $0.07. This yields marginal benefit-cost ratios of approximately 2:1 or 18:1 at scale.

Combining both lime and fertilizer in a 7-message program, we arrive at a marginal benefit-cost ratio at scale of 46 to 1.

Finally, we also consider how the introduction of fixed costs would impact these marginal benefit-cost ratios. To assess this, we rely on 1AF's reported fixed costs associated with running these programs, which are roughly estimated at $1,525. This figure includes one day's salary for senior staff, five days' salary for an associate and field officers, expenses related to transport and incentives for conducting focus groups to test the messages, as well as their overhead. When we factor in these costs, distributed among the number of treated farmers across all projects, the benefit-cost ratio ranges from 4:1 to 14:1. This highlights the critical role of scale. A minimum number of farmers will be necessary to offset the fixed costs, but as the scale increases, these per-farmer costs will asymptotically become insignificant. Organizations with limited outreach, targeting only a few hundred or thousand farmers, will face high per-farmer costs relative to the modest benefits. In contrast, entities such as governments and telecommunications companies, which can often reach a vast number of people, can achieve very favorable benefit-cost ratios.

H Heterogeneity by Experiment

Table H1: Heterogeneous Effects in Following Lime Recommendations

	Logit (OR)					
[X]	Female	Primary School	Large Farm	Young	Used Input	Heard Input
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. KALRO						
Treated	0.595	1.250	0.948	0.768	0.892	0.597
	(0.245)	(0.554)	(0.336)	(0.320)	(0.229)	(0.193)
[X]	0.968	12.394**	0.342	0.677	0.000***	0.508
	(0.834)	(13.037)	(0.358)	(0.587)	(0.000)	(0.493)
[X] *Treated	1.903	0.575	0.764	1.287	1.114	2.773*
	(0.995)	(0.310)	(0.383)	(0.669)	(3.089)	(1.475)
Mean Control	0.12	0.12	0.12	0.12	0.13	0.12
Observations	674	674	674	674	644	674
Add. Controls	N	N	N	N	N	N
Panel B. IPA/PxD1-K						
Treated	1.191	0.981	1.177	1.349	1.170	1.042
	(0.218)	(0.249)	(0.239)	(0.256)	(0.188)	(0.167)
[X]	1.804	0.554	1.078	1.064	1.742	0.236*
	(0.680)	(0.230)	(0.467)	(0.453)	(1.067)	(0.177)
[X] *Treated	0.855	1.299	0.913	0.660	0.882	1.490
	(0.269)	(0.412)	(0.278)	(0.207)	(0.366)	(0.615)
Mean Control	0.25	0.25	0.25	0.25	0.25	0.25
Observations	1854	1854	1854	1854	1854	1854
Add. Controls	N	N	N	N	N	N
Panel C. IPA/PxD2-K						
Treated	1.427***	1.335*	1.211*	1.276*	1.314***	1.218*
	(0.156)	(0.231)	(0.140)	(0.162)	(0.121)	(0.123)
[X]	1.261	1.079	0.885	0.748*	0.977	0.940
	(0.207)	(0.205)	(0.150)	(0.122)	(0.294)	(0.180)
[X] *Treated	0.777	0.971	1.227	1.056	0.944	1.351
	(0.144)	(0.196)	(0.222)	(0.188)	(0.302)	(0.282)
Mean Control	0.30	0.30	0.30	0.30	0.30	0.30
Observations	5732	5732	5732	5732	5732	5732
Add. Controls	N	N	N	N	N	N
Panel D. 1AF1-K						
Treated	1.572***	1.410	1.385***	1.435		
	(0.263)	(0.381)	(0.154)	(0.351)		
[X]	1.175	0.865	1.240	0.654		
	(0.208)	(0.280)	(0.240)	(0.218)		
[X] *Treated	0.818	1.065	0.988	1.052		
	(0.168)	(0.406)	(0.225)	(0.412)		
Mean Control	0.10	0.11	0.10	0.11		
Observations	4812	1151	4884	1151		
Add. Controls	N	N	N	N		
Panel E. 1AF2-K						
Treated	1.186***		1.160***	1.149***		
	(0.070)		(0.041)	(0.042)		
[X]	1.471***		1.213**	0.670***		
	(0.105)		(0.096)	(0.047)		
[X] *Treated	0.961		0.967	1.014		
	(0.067)		(0.070)	(0.070)		
Mean Control	0.33		0.32	0.33		
Observations	31595		32571	31603		
Add. Controls	N		N	N		
Panel F. 1AF3-R						
Treated			1.191**		1.177***	
			(0.085)		(0.073)	
[X]			1.944***		4.292***	
			(0.159)		(0.487)	
[X] *Treated			0.973		1.038	
			(0.090)		(0.133)	
Mean Control			0.04		0.04	
Observations			82873		82873	
Add. Controls			N		N	

Notes: This table shows the results of heterogeneity analysis by experiment. The dependent variable is whether the farmer followed the lime recommendations, measured using administrative data. In Panel A, results are measured through coupon redemption in the second season. We show results for gender, whether the respondent completed primary school, whether the respondent's land is large (defined as above median use of the land size-corresponding input packages bought by 1AF farmers and more than 1.5 acres of land for the other programs), whether the respondent was under 40 years old, whether the respondent had previously used the input, and whether the respondent had previous knowledge of the input. Regressions include randomization strata if used but no additional controls. Effect sizes are reported in terms of odds ratios estimated using logit. Robust standard errors are in parentheses. In panel F, standard errors are clustered at the 1AF group level.* $p < .10$, ** $p < .05$, *** $p < .01$.

Table H2: Heterogeneity in Following Fertilizer Recommendations

	Logit (OR)					
[X]	Female (1)	Primary School (2)	Large Farm (3)	Young (4)	Used Input (5)	Heard Input (6)
Panel A. KALRO						
Treated	1.493	1.135	1.060	1.005	1.133	1.496
	(0.404)	(0.268)	(0.217)	(0.238)	(0.286)	(0.662)
[X]	1.326	2.895*	0.584	0.603	2.730*	1.360
	(0.706)	(1.678)	(0.353)	(0.342)	(1.652)	(1.571)
[X] *Treated	0.632	1.032	1.129	1.226	0.992	0.730
	(0.210)	(0.331)	(0.362)	(0.392)	(0.322)	(0.346)
Mean Control	0.41	0.41	0.41	0.41	0.41	0.41
Observations	773	773	773	773	773	773
Add. Controls	N	N	N	N	N	N
Panel B. IPA/PxD1-K						
Treated	2.197*	1.193	1.942	1.759	1.592	
	(1.014)	(0.779)	(0.959)	(0.779)	(0.671)	
[X]	1.460	0.600	0.154*	1.934	4.226	
	(1.561)	(0.651)	(0.147)	(2.238)	(4.125)	
[X] *Treated	0.404	1.727	0.732	1.121	1.126	
	(0.302)	(1.395)	(0.532)	(0.884)	(0.912)	
Mean Control	0.03	0.03	0.03	0.03	0.03	
Observations	1278	1278	1196	1278	1258	
Add. Controls	N	N	N	N	N	
Panel C. IPA/PxD2-K						
Treated	1.001	1.462	1.410	1.145	1.419	
	(0.233)	(0.627)	(0.382)	(0.315)	(0.332)	
[X]	0.699	1.969	1.996*	0.689	2.430**	
	(0.283)	(0.923)	(0.758)	(0.265)	(1.032)	
[X] *Treated	1.725	0.757	0.665	1.094	0.516	
	(0.769)	(0.365)	(0.263)	(0.437)	(0.230)	
Mean Control	0.03	0.03	0.03	0.03	0.03	
Observations	4024	4024	4024	4024	4024	
Add. Controls	N	N	N	N	N	
Panel D. 1AF2-K						
Treated	1.315***		1.293***	1.281***	1.326***	
	(0.120)		(0.079)	(0.080)	(0.088)	
[X]	1.238***		1.022	0.805***	3.980***	
	(0.082)		(0.082)	(0.051)	(0.297)	
[X] *Treated	0.988		0.980	1.053	1.079	
	(0.101)		(0.105)	(0.109)	(0.118)	
Mean Control	0.15		0.14	0.15	0.14	
Observations	31585		32560	31599	32568	
Add. Controls	N		N	N	N	

Notes: This table shows results of heterogeneity analysis by sample. The dependent variable is whether the farmer followed the fertilizer recommendations, measured using administrative data. In Panel A, results are measured through coupon redemption in the second season. We show results for gender, whether the respondent completed primary school, whether the respondent's land is large (defined as above median use of the land size-corresponding input packages bought by 1AF farmers and more than 1.5 acres of land for the other programs), whether the respondent was under 40 years old, whether the respondent had previously used the input, and whether the respondent had previous knowledge of the input. Regressions include randomization strata if used but no additional controls. Effect sizes are reported in terms of odds ratios estimated using logit. Robust standard errors are in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$.

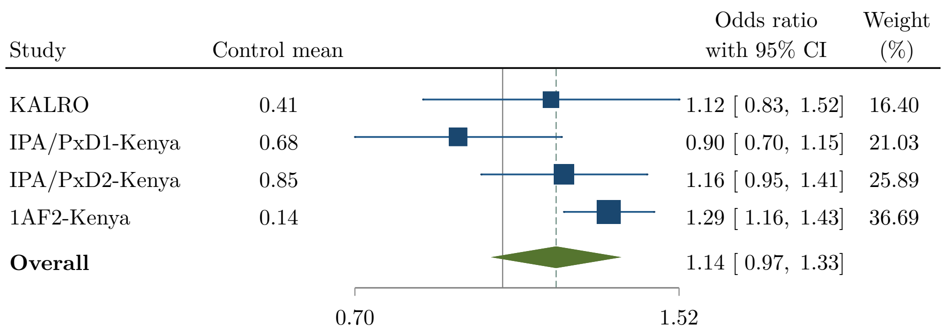
I Additional Meta-analyses

Table I1: Additional Meta-analysis Results

Row #	Outcome	N	Effect	95% CI		95% PI		Q stat (p-value)	I^2	τ^2
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Effects on all inputs and other inputs (index), Standard Deviations										
1	Recommended Inputs (index)	6	0.06	0.03	0.08	-0.01	0.12	0.03	60.58	0.00
2	Other Inputs (index)	5	-0.00	-0.02	0.02	-0.05	0.05	0.10	48.68	0.00
Panel B. Odds Ratios, Sidik-Jonkman										
1	Awareness (Lime)	4	1.21	0.97	1.52	0.48	3.06	0.03	63.84	0.03
2	Knowledge (Acidity)	4	1.52	1.33	1.74	0.99	2.34	0.68	25.52	0.01
3	Lime Rec.	6	1.20	1.08	1.34	0.88	1.65	0.29	62.95	0.01
4	Fert Rec.	4	1.25	1.06	1.48	0.73	2.15	0.67	27.41	0.01
5	Recommended Inputs	6	1.22	1.13	1.31	1.02	1.45	0.50	34.31	0.00
6	Other Inputs	5	0.99	0.89	1.10	0.70	1.40	0.08	74.27	0.01
7	Persistence Lime	4	1.06	0.92	1.23	0.68	1.66	0.71	17.63	0.01
8	Fatigue Lime	3	1.29	1.14	1.46	0.54	3.10	0.82	2.81	0.00
9	Persistence Fert.	4	1.09	0.96	1.23	0.73	1.62	0.60	23.49	0.00
Panel C. Odds Ratios, Restricted Maximum Likelihood										
1	Awareness (Lime)	4	1.21	0.96	1.52	0.46	3.15	0.03	65.44	0.04
2	Knowledge (Acidity)	4	1.53	1.38	1.70	1.21	1.93	0.68	0.00	0.00
3	Lime Rec.	6	1.19	1.12	1.26	1.06	1.33	0.29	11.91	0.00
4	Fert Rec.	4	1.27	1.15	1.40	1.03	1.57	0.67	0.00	0.00
5	Recommended Inputs	6	1.22	1.16	1.29	1.13	1.32	0.50	0.00	0.00
6	Other Inputs	5	1.00	0.92	1.08	0.79	1.26	0.08	55.88	0.00
7	Persistence Lime	4	1.06	0.95	1.18	0.84	1.34	0.71	0.00	0.00
8	Fatigue Lime	3	1.29	1.15	1.45	0.61	2.72	0.82	0.00	0.00
9	Persistence Fert.	4	1.08	0.99	1.19	0.88	1.33	0.60	0.01	0.00
Panel D. Odds Ratios, Empirical Bayes										
1	Awareness (Lime)	4	1.21	0.97	1.52	0.49	3.01	0.03	62.83	0.03
2	Knowledge (Acidity)	4	1.53	1.38	1.70	1.21	1.93	0.68	0.00	0.00
3	Lime Rec.	6	1.19	1.11	1.27	1.03	1.38	0.29	21.67	0.00
4	Fert Rec.	4	1.27	1.15	1.40	1.03	1.57	0.67	0.00	0.00
5	Recommended Inputs	6	1.22	1.16	1.29	1.13	1.32	0.50	0.00	0.00
6	Other Inputs	5	0.99	0.90	1.09	0.73	1.35	0.08	70.08	0.01
7	Persistence Lime	4	1.06	0.95	1.18	0.84	1.34	0.71	0.00	0.00
8	Fatigue Lime	3	1.29	1.15	1.45	0.61	2.72	0.82	0.00	0.00
9	Persistence Fert.	4	1.08	0.99	1.19	0.88	1.33	0.60	0.00	0.00

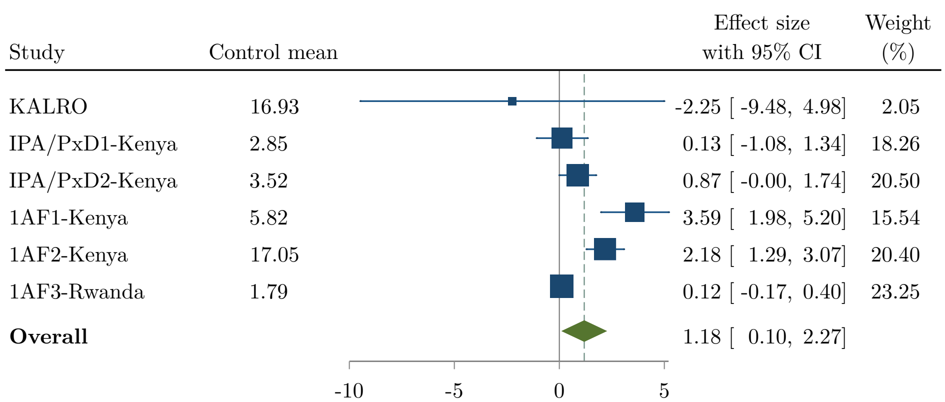
Notes: Results for each meta-analysis are presented by row. Column (1) reports the number of experiments included in the meta-analysis. Columns (2)-(4) display results from random-effects meta-analyses and corresponding 95% confidence intervals, (CI) respectively. Columns (5)-(6) reports 95% prediction intervals (PI). Columns (7)-(9) provide information on heterogeneity measures. Panel A reports results measured in terms of standard deviations. Panel B, C and D results are expressed as odds ratios. The between-study variance estimator is estimated with the DerSimonian–Laird method in panel A, the Sidik-Jonkman method in panel B, the Restricted Maximum Likelihood in Panel C, and the Empirical Bayes method in panel D. *Rec.* stands for Recommended. Qstat (p-value) denotes the p-value for the Q-statistic.

Figure I1: Effects on Any Mentioned Fertilizer (Administrative and Survey)



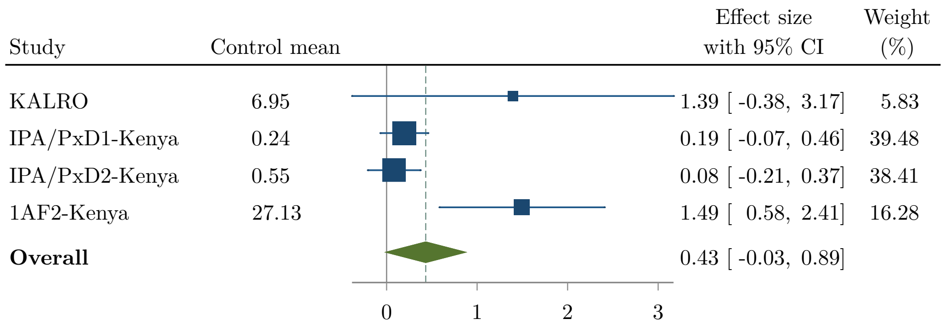
Notes: The figure plots the meta-analysis results for following fertilizer recommendations. The effects are estimated using a random-effects meta-analysis model. Results are reported as odds ratios. The horizontal lines denote 95% confidence intervals. The results are measured using administrative data, where possible, and survey data otherwise. The KALRO results are measured using coupon redemption in the second season. The dependent variable for IPA/PxD1-Kenya is a dummy equal to one if either DAP or urea were purchased. The dependent variable for IPA/PxD2-Kenya is a dummy equal to one if DAP, urea, or CAN were purchased.

Figure I2: Effects on Quantity of Lime Purchased



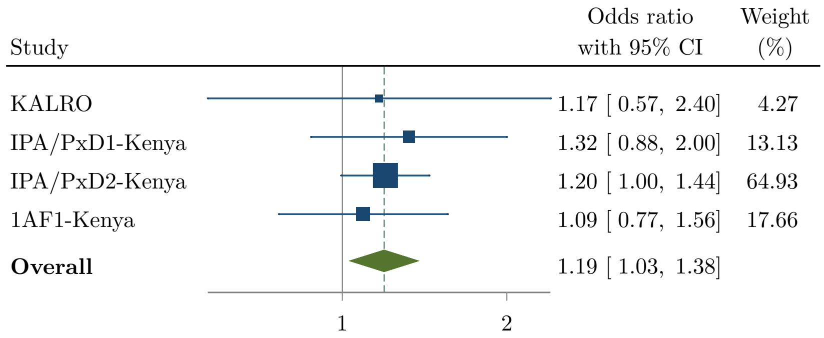
Notes: The figure plots the meta-analysis results for the quantity of lime acquired, measured in kgs and using administrative data. The effects are estimated using a random-effects meta-analysis model. The horizontal lines denote 95% confidence intervals. For IPA/PxD programs, we focus on areas where lime was recommended. The KALRO effects are measured using coupon redemption in the second season.

Figure I3: Effects on Quantity of Fertilizer Purchased

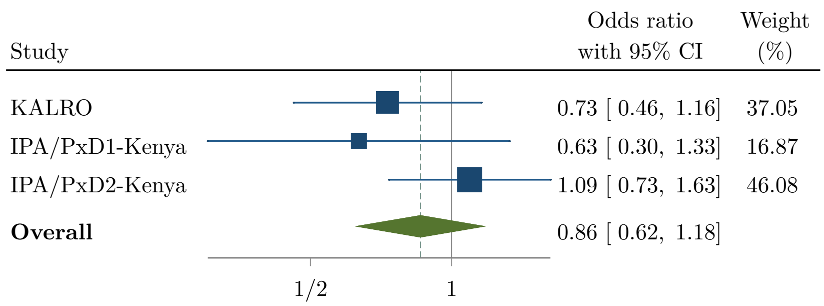


Notes: The figure plots the meta-analysis results for the quantity of fertilizer acquired, measured in kg. The effects are estimated using a random-effects meta-analysis model. The horizontal lines denote 95% confidence intervals. The results are measured using administrative data. The KALRO results are measured using coupon redemption in the second season.

Figure I4: Differences in Survey vs. Administrative Data



(a) Lime: Ratio Survey/Admin OR



(b) Fertilizer: Ratio Survey/Admin OR

Notes: The figure plots the meta-analysis results for the ratio between the effect of the program on following lime recommendations (Figure (a)) or following fertilizer recommendations (Figure (b)), measured in terms of odds ratios, estimated using self-reported survey data, and the same effect estimated using administrative data. The corresponding standard errors are calculated accounting for the correlation between the two estimates. The set of studies is restricted to those for which both self-reported and administrative data are available. The combined effects are estimated using a random-effects meta-analysis model. The horizontal lines denote 95% confidence intervals.

I.1 Bayesian Meta-analysis

As a complementary exercise, we re-examine our results using a Bayesian hierarchical framework (Rubin, 1981; Gelman et al., 1995). The main difference with the random-effects model underlying the frequentist meta-analysis presented in the paper is that in this case, we define (weakly informative) prior distributions for the between-study heterogeneity τ^2 and true effect size μ. An additional advantage of this approach is that the uncertainty of the estimate of τ^2 can be directly modeled and a posterior distribution for μ can be obtained. For a discussion of Bayesian hierarchical models with applications to economics see Meager (2019) and Vivalt (2020). The analysis was implemented using R's baggr's Rubin (1981) model with default priors on the hyper-standard-deviation and hypermean (zero centered and scaled to data) (Wiecek and Meager, 2022).[3]

Table I2: Bayesian Hierarchical Models

Row #	Outcome	N	Effects			Heterogeneity		
			Effect	95% CI		I^2	I^2 - 95% CI	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Odds Ratios								
1	Heard Lime	4	1.23	0.72	1.94	73.4	10.00	98.9
2	Knowledge Acidity	4	1.52	1.14	1.89	41.5	0.10	96.7
3	Lime Rec.	6	1.20	1.07	1.34	42.7	0.16	93.8
4	Fertilizer Rec.	4	1.28	0.86	1.82	44.6	0.13	97.6
5	All Recommended Inputs	6	1.21	1.04	1.40	38.1	0.14	91.1
6	Other Inputs	5	1.00	0.87	1.12	44.0	0.12	96.6
7	Persistence Lime	4	1.07	0.77	1.44	40.8	0.10	96.4
8	Fatigue Lime	4	1.10	0.84	1.41	43.0	0.13	96.7
9	Persistence Fert.	3	1.27	0.82	1.80	46.2	0.16	95.1

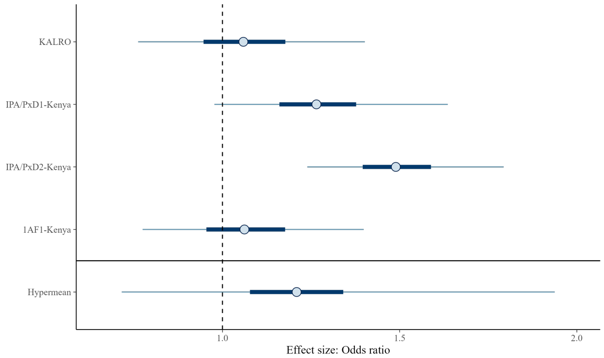
Notes: Meta-analysis results for each outcome reported in the rows. Column (1) reports the number of experiments included in the meta-analysis. Columns (2)-(4) reports effects (in odds ratios); column (5)-(7) reports heterogeneity results.

Figures I5 show forest plots for partially pooled models. While each project is assumed to have a different effects, the data for all the projects inform the estimates for each project. In other words, the bayesian estimation is a weighted average of each project and the average effect across all programs. The idea is that the model 'pools' power across projects, since

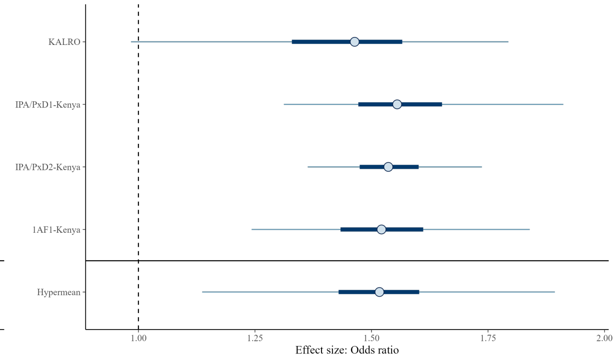
[3] Qualitatively similar results are obtained under different priors. For instance, normal (0,10) priors on the hyper-standard-deviation for the first steps.

projects can provide valuable information about one another.

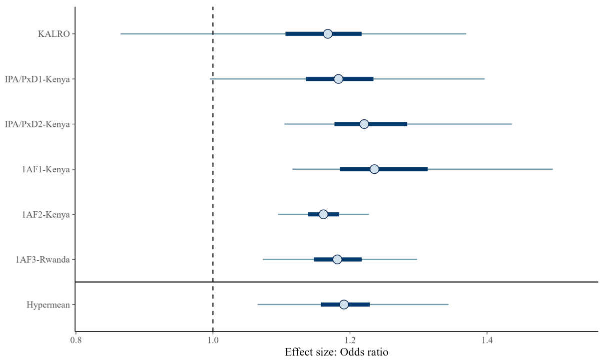
Figure I5: Bayesian Meta-analysis Effects



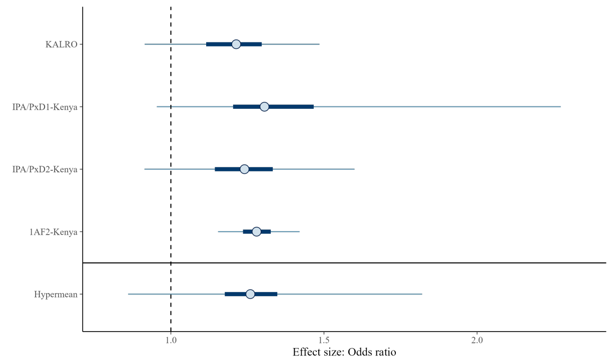
(a) Awareness (Lime)



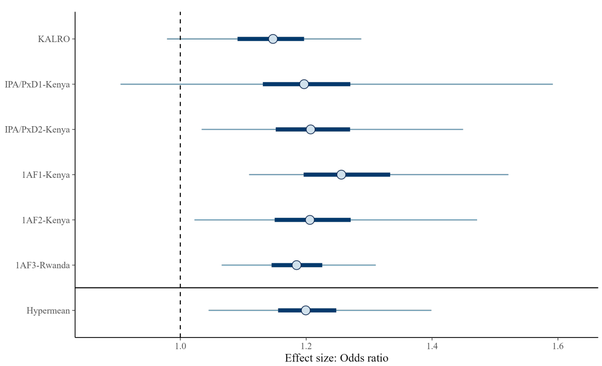
(b) Knowledge (Lime)



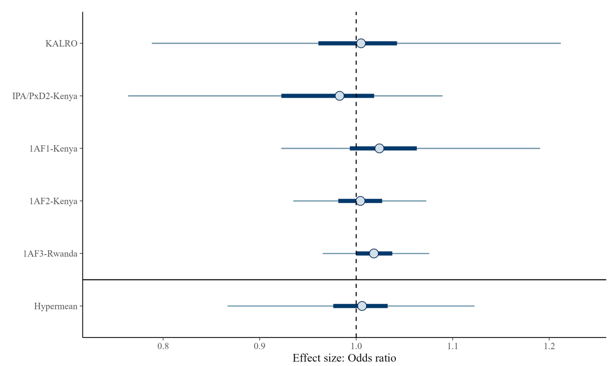
(c) Followed Recommendations (Lime)



(d) Followed Recommendations (Fertilizer)



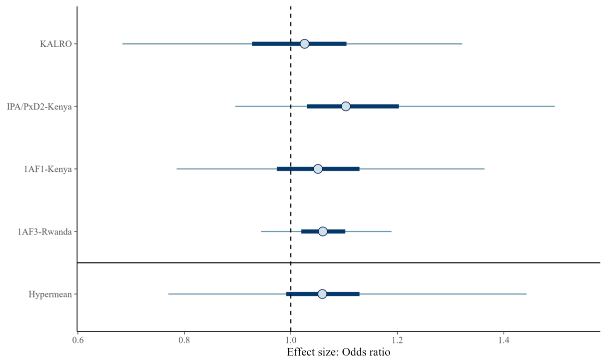
(e) Recommended Inputs



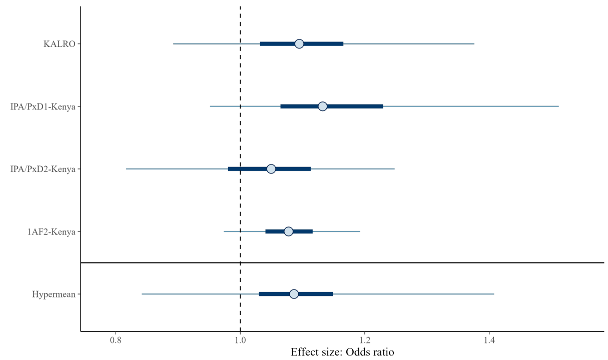
(f) Other Inputs

Notes: The figure plots the meta-analysis results for specific outcomes. The effects are estimated using Bayesian hierarchical models. Results are reported in odds ratios. The horizontal lines denote 95% confidence intervals.

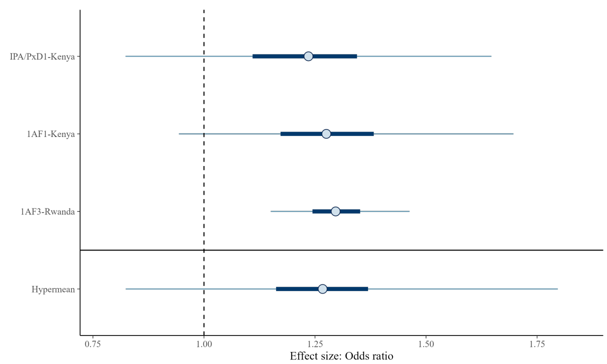
Figure I6: Bayesian Meta-analysis Effects (cont'd)



(a) Persistence (Lime)



(b) Persistence (Fertilizers)



(c) Fatigue (Lime)

Notes: The figure plots the meta-analysis results for specific outcomes. The effects are estimated using Bayesian hierarchical models. Results are reported in odds ratios. The horizontal lines denote 95% confidence intervals.

J Additional Program and Experiment Details

J.1 KALRO's Program

The Kenya Agriculture and Livestock Research Organization (KALRO) is a public agency with the mandate to promote agricultural research and dissemination in Kenya. In 2014 and 2015, KALRO's Kakamega office implemented two extension programs designed to encourage smallholder farmers to use inputs and management practices that could remedy regional soil deficiencies. The purpose of these programs was to reach many farmers at a lower cost than in-person individual extension farm visits. The first program consisted of one-day face-to-face events (farmer field days or FFDs) where many farmers could observe demonstration plots and receive information from extension agents in a group setting. The second program consisted of delivering agricultural messages to farmers via text messages. This paper focuses on the results of the second approach.[4]

KALRO's text-message program consisted of sending 21 agriculture-related text messages to maize farmers' mobile phones during the 2015 short rains season. The content of the messages was developed by the Ministry of Agriculture, Livestock and Fisheries, while KALRO managed the delivery. We list all messages sent by KALRO below:

- We at KALRO- Kakamega shall be sending you 20 SMS tips on how to increase your maize and legume (beans, groundnuts, soybeans) yield
- Keep all the records of your farming activities including inputs and outputs to help you know whether your farming is profitable
- Test your soil after every 4 years. Inquiries: KALRO Tel:[phone] or Soil Cares Ltd: [phone]
- If soil is acidic (pH less than 5.5), apply recommended rate of agricultural lime at least 30 days before planting. Inquiries: Tel.[phone]
- Construct raised bands and trenches to control soil erosion, reduce nutrient loss and keep rain water in the soil
- Add and/or leave all organic matter (manure, crop/weed residues and compost) to your field. Do not burn your fields. Burning destroys useful micro-organisms.
- Prepare land early, at least one plough and one harrow, ready for planting before onset of rains
- Plant before or at the onset of rains. Plant on well drained, fertile soils
- Use certified maize and legume seed recommended for your area, bought from an approved agro-dealer. Use 10 kg maize seed and 40kg of legume seed per acre. Inquiries: [phone]
- Maize and legumes planted in rows are easier to weed & apply fertilizer. You may plant maize alone/pure or together with legumes as follows:
- For pure maize make rows 2.5 feet (75cm) apart and holes 1 foot (30cm) apart along the row. Place 2 and 1 maize seeds in alternate holes.
- For maize and legume intercrop, plant maize as for pure stand and one row of legume (beans, soybean or groundnut) between two maize rows at spacing of 10cm from one hole to another.
- For better maize and legume harvests, inoculate legumes, rotate or intercrop, use fertilizer and manage your crop and soils appropriately.
- Use fertilizer to increases yields. Apply 1 heaped Fanta top of NPK or DAP in each hole for maize, cover with little soil, add seed and cover seed with soil. Fertilizer MUST not touch the seed
- Weeds compete with your crops for nutrients and so reduce yields. Keep fields free of weeds and pests. Thin maize seedlings to 1 plant per hole as you weed.
- Topdress your maize with a level Fanta bottle top of CAN or Mavuno top dress fertilizers 6 weeks after planting. Apply around each plant-5cm away and cover with soil. Apply when soil is moist.
- Harvest as soon as the crops are mature. For maize look for the black eye; for legumes when 90-100% of pods are brown. In late harvests, termites, rodents, insects, diseases & birds reduce yield.
- Remove husk from maize cobs in the field to avoid transporting weevils from the field to the store. The husks will improve the organic matter in the soil.
- Dry your harvest in open sun, but protect it from rain. Thresh/shell and re-dry to moisture content of 11-12%.
- Store your harvest well in silos and helmetic bags. You may also use superactellic during storage – the insects will not touch the grain & is safe.
- Obtain information on favorable market prices before you sell your harvest

[4] We discuss impacts of FFDs in Fabregas, Kremer and Schilbach (2023).

To recruit farmers into these programs, field officers undertook a census of farmers residing in the Ugenya and Mumias sub-counties. The team employed a systematic approach, employing a set of predefined walking rules to visit a representative sample of households in the selected areas. To criteria for eligibility included owning a mobile phone, having cultivated maize or legumes in the previous year, and being responsible for farming activities within their household. A total of 1,330 census surveys were completed, and approximately 94% of those recruited during census activities met the program selection criteria.

In September 2014, farmers completed an in-person baseline survey and were then randomized into the text-message (SMS) treatment (415 farmers) or a comparison group (417 farmers). The randomization was stratified on the basis of area of recruitment, gender, whether farmers had heard about lime, an index of input use (divided into terciles), farm size (above or below median), whether farmers grew legumes, and a cognitive score based on a raven test and a math questionnaire (terciles).

The text-message service started in July and ended in November. An in-person endline survey, asking information about input use and input knowledge, was completed with 93% of the baseline sample at the end of the season, around January 2016. At the end of the endline survey, all farmers also received two physical (paper) discount coupons redeemable at selected agrodealers in their nearest market center.

The coupons were devised as a way to collect data on farmers' input choices while minimizing potential biases caused by enumerator demand effects, as farmers' purchasing decisions were postponed to a later time when they were not directly observed by any member of the research or KALRO teams. The first discount coupon was redeemable for a 50% discount for agricultural lime. The second coupon was redeemable for a 50% discount for any chemical fertilizer of their choice (NPK, DAP, CAN, urea or Mavuno). Both coupons had an upper limit discount of 1000 Ksh (approximately $10 USD). Coupon redemption was possible up to the start of the subsequent long rain agricultural season (around March 2016). Participating agrodealers were instructed (and incentivized through a small payment) to keep clear records on input choices and quantities purchased by farmers who redeemed coupons. Coupons could be linked to farmers through unique IDs. Incentives for shopkeepers were paid on the basis of having both the physical coupon and a record of the purchase in their logbooks.

J.2 IPA & PxD's Programs

PxD supported two agricultural extension research projects in western Kenya that were implemented and evaluated with support from IPA.

J.2.1 IPA/PxD1-K

Throughout the 2016 short rains agricultural season, IPA and PxD sent farmers in western Kenya text messages with information about agricultural inputs (including lime and chemical fertilizers), as well as other general agronomic recommendations on maize farming. Farmers who participated in this program were recruited through administrative farmer records of a large agribusiness in the region (denoted MSC farmers) and from records of individuals who had participated in previous IPA's activities (denoted IPA farmers).[5] In July 2016, a random sample of farmers from both databases were contacted over the phone to invite them to participate in this study and complete a short phone-based screening survey to determine eligibility. Farmers who were planning to plant maize in the 2016 short rains season, had a farm located within the intervention areas, and expressed interest in receiving agricultural information over their phone were invited to participate. From 2,255 targeted respondents, 2,131 consented to participate, and 1,897 (89%) met the criteria for selection.

This final sample was randomized into three groups: receiving the general messages ("General"), receiving specific messages for their area ("Specific"), and a control group. The randomization was stratified based on database origin, area, gender, prior lime and urea use, a knowledge score (below or above median), farm size (divided in terciles), whether they had indicated a positive willingness to pay for the messages and whether they had replied to a phone-based poll at baseline.

Customized recommendations used the best available soil data for each area. Farmers

[5] The Mumias Sugar Company (MSC) ran a contract farming model with sugar cane farmers in the region up to 2015. The vast majority of MSC farmers planted maize in addition to sugar cane, so the company supported the delivery of maize extension messages. The farmers who appeared in the IPA database were mainly recruited through school meetings for other IPA projects. This group accounted for about 47% of the final sample.

received between 24 and 28 messages. Messages were sent in English or Swahili, depending on farmers' preferences indicated during the baseline phone survey. We report all the messages below: [G] indicates that the message was received by the General treatment group, and [S] denotes it was received by the Specific treatment group.

- [G/S]: Welcome to PxD's SMS information service. We will give you tips on agricultural inputs to apply on 1/8 of an acre so you can experiment during this short rains season. Receiving SMS messages is free.
- [G]: High soil acidity levels reduce nutrients available to plants, such as phosphorus, which causes symptoms of stunted growth and purple colouration of maize.
- [S]: Previous soil tests of shambas around [landmark] showed [degree] soil acidity levels. High acidity levels reduce nutrients available to plants, such as phosphorus, which causes symptoms of stunted growth and purple colouration of maize.
- [G]: Lime reduces soil acidity and makes nutrients such as phosphorus available for your maize.
- [S]: Based on soil tests of shambas around [landmark], we recommend you buy [quantity] kg of lime, [quantity] kg of DAP, and 6 kg of urea for microdosing 1/8 acre of your maize. Lime reduces soil acidity and makes phosphorus available for your maize.
- [S]: We would like you to try our recommendations in 1/8 of an acre. To measure 1/8 of an acre, walk around your farm and draw a square with each side 33 steps long. Walk normally, don't make long strides. If you land is a rectangle, the sum of 2 sides should measure in total 66 steps. Start from a corner, walk along the short side, count your steps until you reach the end. Turn around and keep walking along the long side until you finish counting 66 steps.
- [S]: When planting this season try adding a layer of lime [quantity] bottletop, then cover with soil and add a second layer of DAP ([quantity] bottletop) per hole on 1/8 acre to correct soil acidity and make more nutrients available for your plants. Apply 1 bottletop of urea per hole at top dressing.
- [G]: Use a ruler or measured rope to plant maize in rows using correct spacing of 75 cm x 25 cm. This offers maximum yield while limiting competition for nutrients, light and water.
- [S]: Use a ruler or measured rope to plant maize in rows using correct spacing of 75 cm x 25 cm. This offers maximum yield while limiting competition for nutrients, light, and water. You should be able to fit 2580 planting holes in 1/8 of an acre. Use sisal twine to encircle this area so you can compare the results at harvest.
- [S]: Have you bought lime and DAP yet? If not, buy a total of [quantity] kg of lime and use with [quantity] kg DAP for microdosing on 1/8 of your acre. DAP is the most cost efficient source of phosphorous. When lime is combined with DAP, it reduces soil acidity and makes nutrients available for your maize.
- [G]: Calcium lime is safer for your health and the plant. This lime could be either brown or grey.
- [S]: [agrovet] will be stocked with lime (calcium lime) and DAP during this short rain season. This lime is brown and it is safer for your health and the plant. It is also heavier than the white lime so you only need to apply [quantity] bottletop per plant. The price of lime today is Ksh 7 per kg. The price of DAP today is Ksh [price] per kg.
- [G/S]: Plant maize seed when there is enough moisture after 2-3 rains, to enable absorption of water by seed and fertilizer. Delayed planting leads to reduced yields. To stop receiving these SMS messages reply "STOP".
- [G/S]: Plant two maize seeds per hole to ensure one survives. Do not use broken or damaged seeds because they will not germinate. Use certified seeds, they grow faster and are high yielding.
- [G]: Are you ready to plant your maize? We recommend you apply both lime and fertilizer in micro-doses at planting. 5 weeks later, we recommend you apply top dressing fertilizer in micro-doses
- [S]: Do you know the 5 Golden Rules for successful micro-dosing? Based on soil tests performed around [landmark], we recommend you to: Apply [quantity] bottletop of lime and cover with soil and then add [quantity] bottletop of DAP. Cover with 2 inches of soil. Use 2 seeds per planting hole. Cover the seeds with 2 inches of loose soil. Apply 1 bottletop of urea as top dressing fertilizer 5 weeks later when the plant is knee-high.
- [G/S]: Remember, lime should only be used during planting and not at top dressing. Lime is not a fertilizer and could burn the plant if applied at top dressing.
- [G/S]: At planting, if you are applying lime in micro-doses, remember to cover it with soil before applying fertilizer and planting seeds. Lime should not be in direct contact with the seeds as it may burn them. When you apply lime, wear protective clothing such as long sleeves and gloves. Cover your mouth and nose with a scarf and wear goggles.
- [G/S]: Gap your maize immediately after emergence. Gapping is done by re-planting maize seeds in places that have not germinated. This gives you optimum plant population that leads to optimum yields.
- [G/S]: During first weeding, thin to one maize plant per hole. You should remove striga immediately to reduce competition for nutrients and water, and to prevent stunted growth!
- [G]: Have you already planted your maize this season? If not, we recommend applying lime at planting. Lime reduces soil acidity and makes nutrients such as phosphorus available for your maize.
- [S]: Have you already planted your maize this season? If not, we recommend applying lime at planting. We recommend you apply [quantity] bottletop per planting hole. Buy [quantity] kg of lime to experiment on 1/8 of an acre. Lime reduces soil acidity and makes nutrients such as phosphorus available for your maize.
- [G]: If you applied lime on your maize at planting, we recommend using urea at top dressing because it is a less expensive source of nitrogen.
- [S]: If you applied lime on your maize at planting, we recommend using urea for top dressing because it is a less expensive source of nitrogen. Buy 6 kg of urea for use on 1/8 of an acre.
- [S]: [agrovet] will be stocked with urea during this short rain season. The price of urea is Ksh [agrovet] per kg.
- [G]: When the maize reaches knee high (5 weeks after planting), apply top dressing fertilizer.
- [S]: When the maize reaches knee high(5 weeks after planting), based on soil tests around **[landmark]**, we recommend you apply 1/2 bottletop of urea per plant, making a 15 cm circle around the maize plant.
- [G/S]: Conduct second weeding 6 or 7 weeks after planting. Uproot all striga before it produces seeds because it reduces maize yields if not removed
- [G/S]: We invite you to participate in an SMS poll to help you recognize potential maize diseases and provide advice. Reply OK to start. Messages are free.
  - Do you see straight lines of holes on newly formed maize leaves?
    [if yes] This could be stalk borers. Apply insecticide, e.g. bulldock or tremor, into the funnel or spay the maize plant with pentagon at top dressing.We hope this information was helpful. We will be sending another poll question tomorrow. Thank you!
    [if no] This is good news! Thank you for answering our question. We will send another question tomorrow.
  - Do you notice yellow or white streaks or discoloration on the leaves of your stunted maize plants? [if yes] It could be Maize Streak Virus. Eradicate grass weeds and use malathion or dimethoate to control as soon as possible. We hope this information was helpful. We will be sending another poll question tomorrow. Thank you!
    [if no] This is good news! Thank you for answering our question. We will send another question tomorrow.
  - Do you see striga weed in your maize plot? Striga has thin leaves and pink or purple flowers and attaches onto the maize roots.
    [if yes] Uproot all striga that has emerged. Striga competes with your maize for nutrients, water, and light and leads to reduced maize yields. We hope this information was helpful. We will be sending another poll question tomorrow. Thank you!
    [if no] This is good news! Thank you for answering our question. We will send another question tomorrow.
  - Do you see ants that cut maize stalks and feed on fallen maize

cobs?
[if yes] It could be termites. Dig out all anthills around your maize farm and ensure that you destroy the queen. Alternatively, you can dig a deep hole at the center of the anthill and use insecticide to kill the ants. We hope this information was helpful. This is the last poll question. We will NOT send another question tomorrow. Thank you for your participation!
[if no] This is good news! This is the last poll question. We will NOT send another question tomorrow. Thank you for your participation!

- [G/S]: WEEDING REMINDER! Conduct second weeding 6 or 7 weeks after planting. Weeds compete with your maize for nutrients, water, and light, which reduces yields.
- [G]: Have you already applied top dressing fertilizer on your maize? If not, we recommend using urea at top dressing because it is a less expensive source of nitrogen.
- [S]:Have you already applied top dressing fertilizer on your maize? If not, we recommend using urea at top dressing because it is a less expensive source of nitrogen. Buy 6 kg of urea for use on 1/8 of an acre and apply 1/2 bottletop of urea per plant. Apply urea when there is enough moisture in the soil to avoid loss through evaporation.
- [G/S]: Harvest maize at physiological maturity when cobs droop and leaves dry. Dry maize in the sun even after shelling to avoid mold and attack by weevils. Maize grain must remain dry and clean during storage to avoid reduction in quantity and quality.
- [G/S]: We hope you enjoyed these messages from Precision Agriculture for Development. Our team will follow up with a phone call in the coming weeks to hear more about how your planting season went.

Two electronic discount coupons were sent via text message to all participating farmers, including those in the control group, during the short rains 2016. Farmers could redeem coupons in agricultural supply dealers in their preferred or closest market center as specified at baseline. For most farmers, it was possible to redeem the coupons in several different agrodealers. The first coupon was sent ten days after the beginning of the experiment after seven recommendation messages, followed with a reminder one week later. The first coupon gave farmers a choice of either 10 kg of lime or 1 bar of soap. The purpose of allowing farmers to select between lime and another comparable product of equal value was to capture farmers' input preferences free from other liquidity constraints.

The second coupon was sent one month after the beginning of the experiment, after 18 messages, with a reminder after ten days and another 20 days later. This coupon provided a 30% discount on one type of top-dressing fertilizer (urea, CAN, or Mavuno), up to a pre-discount amount of 500 Ksh (approximately $ 5 USD). During this program, 32 agrodealers in 25 distinct market centers participated in coupon redemption.

Additionally, during the following 2017 long rains season, all treated farmers received five identical text messages about agricultural lime:

- [If pH≤5.5]: The soil in your area is [level] acidic. To avoid low yields, treat now. Apply [quantity] bottletop of lime per planting hole. [quantity] lime per 1/4 acre.
- [If pH>5.5]: The soil in your area is slightly acidic. According to our analysis, farms in your area do not need lime.

A phone endline survey was conducted mid-2017 long rain season, with the full sample of farmers participating in the experiment. The survey included questions about input use during the 2016 short rain and 2017 long rain agricultural seasons, as well as farmers' general agricultural knowledge. Enumerators completed surveys with approximately 80% of farmers in the sample. Farmers also received a lime coupon via text, which was redeemable for a 15% discount.

J.2.2 IPA/PxD2-K

The second IPA/PxD program recruited farmers through agricultural supply dealers. A total of 144 agricultural supply dealers in 60 market centers invited farmers to provide their phone numbers if they were potentially interested in participating in an IPA/PxD program. The registration period ran from early December 2016 to late January 2017. A total of 8,496 farmers were registered. For logistical reasons the study area was later restricted to 46 market centers, which contained 102 agricultural supply dealers. Farmers in these centers were then contacted over the phone by a member of the research team to obtain consent and to complete a baseline survey, which contained questions about their farming practices and previous input use. A total of 5,890 farmers completed the phone baseline survey, met the eligibility criteria, and resided in eligible areas for which PxD had soil information.[6]

Farmers were then randomized into four groups. The first three groups received PxD's text message information services, and the fourth group remained as a control. One-third of treated farmers only received information via text (SMS only), another third received SMS and were invited to express interest in receiving a phone call that would explain the messages (SMS+Call Offer), and the last third of treated farmers were directly contacted over the phone and offered an explanation of the messages (SMS+Call). The randomization was stratified by gender, prior lime use, and by the agrovet that recruited the farmers.

Messages were sent during the 2017 long rains season and were based on ward-level soil test data. Wards were chosen because they are one of the smallest units that farmers can self-report and that soil tests could be mapped into.[7]

The messages focused on three types of recommendations: the use of agricultural lime in wards with median soil pH below 5.5, the use of planting fertilizer, and the use of top-dressing

[6] From the original sample, farmers who were reached but did not complete the baseline survey included 257 who did not consent to participate in the study, 53 who were not planning to grow maize in 2017, and 40 who lived outside the four counties in which recruitment took place. Approximately 1,017 farmers lived in wards for which there was no soil test data available.

[7] In western Kenya, the average size of a ward is 12 km^2.

fertilizers, primarily urea. Messages were sent in either English or in Swahili, depending on farmers' language preferences at the time of registration. We list them below [A] indicates that all treated groups received the message, and [SCO] denotes it was received by the 'SMS + Call Offer' group.

In addition to these messages, the 'SMS+ Call' [SC] group received a call from an extension officer to explain these messages. This phone call did not provide any additional information, but it allowed farmers to ask clarification questions to a PxD field officer and to hear the explanation multiple times. The purpose of the phone call was to strengthen the information provided via text. The 'SMS+ Call Offer' group would receive the same call, if they dialed a number provided to them.

- [A] Welcome to PxD, IPA's free advice service for maize growers. You will receive advice for your needs based on more than 10,000 soil tests from western Kenya.
- [A] The soil in your area is [level] acidic. To avoid low yields treat now. Apply [quantity] bottle top of lime per planting hole. [quantity] kgs for 1/4 acre. OR The soil in your area is slightly acidic. According to the soil analysis, farms in your area do not need lime.
- [A] Soil acidity causes stunted growth. Lime reduces soil acidity and makes nutrients of DAP more available for your maize.
- [A] When planting, apply [quantity] bottle top of lime. Cover with a handful of soil. Add [quantity] bottletop of DAP, cover with enough soil to avoid direct contact of inputs. OR When planting, apply [quantity] bottle top of DAP, cover with enough soil to avoid direct contact of inputs.
- [A] Check your phone! We sent you 3 planting recommendations last week./ [if SCO] If you flash [number] before Friday this week, we will you callback soon to explain them/ [iF SCO] We will call you soon to explain them]
- [A] Top-dress when your maize has more than 4 leaves up to knee-high. If rains are good apply [quantity] bottle top of UREA. If rains are low, apply [quantity] bottle top of CAN.
- [A] UREA can increase your maize yields as much as CAN if rains are good. Try [quantity] kg of urea in 1/4 acre and see the results.
- [A] Check your phone! We sent you 2 top-dressing messages this week./[if SCO] If you reply YES or flash [phone] by Tuesday, we will call you back soon to explain them./ [if SC] We will call you soon to explain them.

All farmers participating in the experiment received two electronic coupons via text message. Each coupon allowed farmers to obtain discounts on agricultural inputs from local agricultural supply dealers in their area. Each farmer could choose to redeem the coupons at several available agrodealer options. The first electronic coupon was redeemable for 15% on the first seven 10 kg bags of agricultural lime, and the second coupon provided a 15% discount on the first 1,000 Ksh (approximately $10 USD) spent on top-dressing fertilizers (urea, CAN, or Mavuno). To ensure that all farmers in the treatment and control groups were equally aware of the coupon, all farmers received a phone call a week before the coupon was sent, in which an enumerator explained how to use the coupon and at which agricultural supply dealers the coupons could be redeemed. 93% of farmers were reached during this activity.

Finally, a phone-based endline survey was completed with this sample. Because of logistical constraints, the survey sample was randomized into two groups: completing the survey early (towards the end of the 2017 long rains) or completing the survey late (towards the end of the 2017 short rain season). Approximately one third of the sample was assigned to complete it early and the rest to complete it late. In total, 84% of the initial sample completed the survey.

Both versions of the survey included questions regarding the farmers' agricultural knowledge and input use during the 2017 long rain season. Additionally, the late survey had questions about input use during the 2017 short rain season. To measure persistence, we use data from the subsample of farmers who were randomly assigned to complete the late version of the survey and reported lime use for two seasons.

J.3 One Acre Fund's Programs

1AF operates in six countries in Eastern and Southern Africa. In 2017, they were working with over 600,000 farmer clients (1AF, 2017). The standard input bundle that 1AF offers on credit includes hybrid seeds and chemical fertilizers. However, to address the problem of high soil acidity, 1AF offered farmers agricultural lime as an optional add-on. Yet, across their many locations, demand for lime remained low. Hypothesizing that this could reflect a lack of awareness, 1AF designed and evaluated several digital informational programs to increase lime take-up. Since 1AF field officers already followed detailed protocols, a key objective of this approach was to test cheap programs that would not require additional field officer training and delivery.

J.3.1 1AF1-K

Before 2016, less than 3% of 1AF clients in western Kenya purchased agricultural lime through the organization (1AF, 2015). To increase take-up, 1AF designed a phone-based extension pilot that consisted of six text messages targeting clients who had signed up for the 1AF input program during the previous season in a selected district of western Kenya.

In September 2016, just before the period when farmers placed their input orders for the 2017 long rains season, 1AF sent text messages about soil acidity and agricultural lime. Two types of messages were sent: the first, denoted as "Broad", simply encouraged farmers to use lime to reduce soil acidity and increase yields, while the second, denoted as "Detailed" provided recommendations on lime application rates and expected yield increases, customized to the farmers' site.

Customized messages were based on soil tests conducted by 1AF in the region. In total, 4,884 farmers participated in the experiment, with 3,325 randomly assigned to receive messages and 1,559 remaining as a control. The same text message was sent six times in Swahili. We report the messages below:

- [Broad]: Hello [name],Your soil is acidic. Use lime to reduce acidity and increase yields.Call xxx-xxxx.
- [Detailed]: Hello [name],Your soil is [level] acidic. We recommend [amount] kg of LIME per acre at [total cost] Ksh. Use lime to reduce acidity and increase yields [percentage increase]%.Call xxx-xxx.

To measure outcomes, we use data from two sources: 1AF administrative records and a phone survey conducted with a random subsample of farmers. The administrative data includes details on inputs purchased on credit through the 1AF program for the 2017 long rains season. However, only around 60% of the farmers who received the text messages later registered to obtain 1AF inputs. Input purchases are conditional on enrolling in the 1AF program. As described earlier, we find no evidence that the messages affected the likelihood of being enrolled in the 1AF input program, but we take a conservative approach and define our main outcome as lime purchases acquired through 1AF, coding as zero those who did not enroll.

To gather additional information from farmers, researchers conducted a follow-up phone survey in summer 2017 with a random subsample comprising 30% of the experiment's farmers. This survey asked respondents about their lime knowledge and input use during the 2017 long rains season. Approximately 79% of the contacted farmers completed the survey.

In September 2017, just before the enrollment for the 2018 long rains season input program, farmers in the experiment who had also enrolled in the 1AF input program in 2017 were re-randomized into receiving additional messages about lime. A total of 2,931 farmers were re-randomized, essentially resulting in the creation of four groups: farmers who never received messages, farmers who received messages during two seasons, farmers who were only treated just before the 2017 1AF input season, and farmers who were only treated just before the 2018

1AF input season. At this point they received the following message one to five times:

- 1AF recommends you register to buy lime for your maize.

Outcomes for this season are measured through 1AF administrative records for the 2018 long rains season.

J.3.2 1AF2-K

A second 1AF program was implemented with approximately 30,000 farmers in four Kenyan districts in September 2017. Former 1AF clients were randomized into a no message control group or a treatment group receiving texts to encourage lime adoption. Additionally, a quarter of farmers were randomly assigned to receive additional messages encouraging additional fertilizer use (extra CAN) for top-dressing.

Farmers participating in the study were randomized to receive one of six types of messages. The first type was a “Basic” message that simply recommended the purchase of lime. The second type, labeled “Yield increase”, emphasized that using lime could lead to higher maize yields. Additionally, two message arms encouraged experimentation, known as “Experimentation (selfish)” and “Experimentation (neighbors)”, each highlighting individual or social benefits from experimenting with lime. Another type of message, “Social comparison”, encouraged farmers to keep up with their neighbors, and the “Self-efficacy” text emphasized farmers ability to increase their yields. In an additional randomization, half of the treated farmers received messages addressing the entire family rather than just the individual (replacing the word ‘you’ with ‘your family’).

The messages encouraging the use of additional quantities of fertilizer were identical to those promoting the use of lime, with the word “Lime” replaced by “Extra CAN”. Farmers assigned to receive both lime and fertilizer messages were randomly assigned to receive one type first, followed by the other on the next day for all repetitions. The number of repetitions, ranging from 1 to 5, was cross-randomized. Below, we provide the messages:

- [M1: Basic] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize.
- [M2: Yield increase] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize. You'll get higher yields by using [Lime/Extra CAN].
- [M3: Experimentation (selfish)] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize. Try it on just a small part of your land to see the benefits.
- [M4: Experimentation (neighbors)] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize. Try it on just a small part of your land to so that you and your neighbors can see the benefits.
- [M5: Social Comparison] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize. Farmers all over western are getting bigger yields by using [Lime/Extra CAN]. Keep up with them!
- [M6: Self-efficacy] [Name], 1AF recommends [you/your family] register to buy [Lime/Extra CAN] for your maize. You have the ability to achieve higher yields by using [Lime/Extra CAN]!

In September 2018, at the time of enrollment for the 2019 long rains season input program, all the farmers who purchased inputs from 1AF for the 2018 long rains season received additional messages encouraging lime adoption (but no messages about fertilizer).

Farmers were later matched to 1AF administrative data to measure their likelihood of demanding agricultural lime and fertilizer for the 2018 and 2019 agricultural seasons.

J.3.3 1AF3-R

In Rwanda, 1AF, locally known as Tubura, had established a partnership with the government to provide farmers in the region with access to agricultural products, services, and training. Since 2016, they had been collaborating to promote the widespread adoption of agricultural lime. In 2017, 1AF introduced a text-message-based program designed to encourage experimentation with a specific type of agricultural lime called travertine.

Due to the relatively low mobile phone penetration in the country, 1AF sought to investigate potential spillover effects within farmers' groups. To capture this, randomization was implemented at both the group and individual levels. Initially, farmer groups were randomly assigned to one of three categories: a pure control group, where no farmers received messages; a pure treatment group, where all farmers with phones received messages; and a partially treated group, where farmers with phones had a 50% chance of receiving the messages. The framing and frequency of the messages (ranging from 1 to 5 repetitions) were also randomized. [8] The message framing variations included:

[8] 1AF randomized some groups to receive the same message, while in others, messages were randomized within groups. The number of repetitions was randomized within groups. In the main analysis, we present effects with clustered standard errors at the group level. However, specifications with unclustered standard errors lead to very similar conclusions.

- [T1-G: General promotion (gain)] Many fields in Rwanda have acidic soil and need TRAVERTINE to increase yields. Order from TUBURA now.
- [T1-L: General promotion (loss)] Many fields in Rwanda have acidic soil and need TRAVERTINE to avoid a yield loss. Order from TUBURA now.
- [T2-G: Specific+ yield impact (gain)] Many fields in Rwanda have acidic soil. Applying 25 kg/are of TRAVERTINE will increase yields by 20%.Order from TUBURA now.
- [T2-L: Specific+ yield impact (gain)] Many fields in Rwanda have acidic soil. Applying 25 kg/are of TRAVERTINE will prevent a yield loss of 20%. Order from TUBURA now.
- [T3-G: Self-diagnosis (gain)] Do you have fields with poor harvests even when you use fertilizer? You probably have acidity and need TRAVERTINE to increase yields. Order from TUBURA now.
- [T3-L: Self-diagnosis (loss)] Do you have fields with poor harvests even when you use fertilizer? You probably have acidity and need TRAVERTINE to avoid a yield loss. Order from TUBURA now.
- [T4-G: Soil test (gain)] Ask your Field Officer for a free soil test to learn if your fields are acidic and you need to order TRAVERTINE to increase yields.
- [T4-L: Soil test (loss)] Ask your Field Officer for a free soil test to learn if your fields are acidic and you need to order TRAVERTINE to avoid a yield loss.
- [T5-G: How travertine works (gain)] Many fields in Rwanda have acidity, which blocks fertilizer uptake. Applying TRAVERTINE solves the problem, increasing crop yields. Order from TUBURA now.
- [T5-L: How travertine works (loss)] Many fields in Rwanda have acidity, which blocks fertilizer uptake. Applying TRAVERTINE solves the problem, preventing a yield loss. Order from TUBURA now.
- [T6-G: Order immediately (gain)] Many fields in Rwanda have acidic soil and need TRAVERTINE to increase yields. Order it immediately, when signing your TUBURA order form.
- [T6-L: Order immediately (loss)] Many fields in Rwanda have acidic soil and need TRAVERTINE to avoid a yield loss. Order it immediately, when signing your TUBURA order form.
- [T7-G: Your cell is acidic + yield impact (gain)] In your cell the soil is acidic. If you apply 25 kg/are of TRAVERTINE you can boost yields by 20%. Order from TUBURA now.
- [T7-L: Your cell is acidic + yield impact (loss)] In your cell the soil is acidic. If you apply 25 kg/are of TRAVERTINE you can avoid a yield loss of 20]%. Order from TUBURA now.

Out of a total of 202,972 farmers registered with 1AF, 110,400 had a phone in the 1AF database. As an outcome measure for the first season, we consider whether farmers purchased lime from 1AF in the 2018 agricultural season (about 62% of farmers who received messages, enrolled in the 1AF input program that year).

In the main analysis, we compare the outcomes of farmers from the fully treated and those assigned to treatment in the partially treated groups against those in the pure control farmer groups (we exclude those assigned to control in partially treated groups).

During the subsequent season, farmer groups composed of individuals who had enrolled in the 1AF program in 2018 were re-randomized to receive messages. These groups were assigned to either full control or the partially treated assignment. This resulted in three types of treatment assignments: farmers who never received messages, those who received messages during two seasons, and those who received messages only during the first or second season.

- [M1: Basic Message] Hi [Name], use travertine, fertilizer and compost on your fields this season to get a better harvest. Buy travertine and fertilizer from Tubura!
- [M2: Feed your family] Hi [Name], use travertine, fertilizer and compost on your field this season. You'll get better harvests to feed your family. Buy travertine and fertilizer from Tubura!
- [M3: Social comparisons] Hi [Name], some Tubura farmers have doubled their harvest by using travertine with fertilizer and compost. Buy travertine and fertilizer from Tubura!
- [M4: House metaphor] Hi [Name], to get great harvests, you build your soil's strength like you build a house. Compost is the foundation, travertine is the strong frame, and fertilizer is the roof. Buy travertine and fertilizer from Tubura!

To analyze the effects on persistence, we include untreated farmers assigned to partially treated groups during the second season. However, excluding this group does not change the conclusions.

During this season, 66% of those who were re-randomized re-enrolled in the 1AF program and were, therefore, eligible to order lime during the 2019 season.

K Agricultural Recommendations

In this section, we first describe how the agronomic recommendations were constructed. We then discuss how informative area-level recommendations might have been for individual farmers, and the potential for errors of inclusion.

K.1 Generating Agricultural Recommendations

KALRO. Officials and extensionists from KALRO and the Ministry of Agriculture developed the content of the messages. The recommendations were crafted based on the officials' knowledge of broad agro-ecological zones and the types of soils in western Kenya. KALRO classifies all the regions where they worked as having acidic soils (Kanyanjua et al., 2002), but farmers were advised to test their own soil and use the recommended amount of lime resulting from those tests.

IPA-K/PxD1-K. Recommendations were crafted by agronomists based on available soil data. All farmers were linked to a nearby identifiable landmark with associated soil data. This approach was necessary due to the absence of consistent village names or addresses in this context. Farmers recruited through the IPA database were matched to their closest primary school and were provided with recommendations based on soil tests performed around these schools (the vast majority were within 1 km of the landmark and almost all within 2 km). Soil data for these recommendations was previously collected for other IPA projects in 2011 and 2014 (Fabregas et al., 2017) and analyzed by the Kenya Agricultural Research Institute (KARI) using wet chemistry. Lime quantities were calculated based on the standard lime factor of 1.5 times the exchangeable acidity (Kamprath, 1970). Farmers recruited through the MSC database were already assigned to a specific 'company field', a set of plots cultivated by multiple farmers and aggregated by the company for conducting activities, including soil testing. Lime recommendations were based on median pH, with those in areas with a median pH over 5.5 not receiving lime messages. Among both these samples, approximately 18% did not receive messages about lime.

Farmers also received messages about planting (DAP) and top-dressing (urea) fertilizers.

The amount of planting fertilizer recommended was based on the median amount of phosphorus measured in the area, which determined the recommended quantity of diammonium phosphate (DAP).

Top-dressing fertilizer recommendations were based on the quantity of nitrogen required to achieve a certain expected yield. The quantity was selected based on the target yield of 2 t/ha, which is standard for the area. Urea was recommended, given that it was a cheaper source of nitrogen.

IPA-K/PxD2-K. Farmers participating in this study were provided with lime recommendations based on the median soil pH in their ward. Only those with median pH below 5.5 were recommended to lime (77% of the sample). Planting fertilizer (DAP) recommendations were based on median values of phosphorous. The recommended DAP quantities were based on a target yield of 2 t/ha, which was chosen as it represented an improvement with respect to the baseline average yield of 1.42 t/ha, while keeping the cost of the input package affordable.

Top-dressing fertilizer recommendations were based on the quantity of nitrogen required to achieve a certain expected yield. As with the first project, the objective of the messages was to encourage farmers to experiment with urea, a less commonly used fertilizer. Farmers were advised to opt for urea if the rainfall conditions were good. While urea is a cheaper source of nitrogen, its efficiency diminishes in dry conditions due to the potential for ammonia volatilization. Messages mentioned CAN as an option for top-dressing if rains were low. Since rains were considered good during this season, we take experimentation with urea as the primary indicator of following recommendations. However, we also show impacts if either CAN or urea were used.

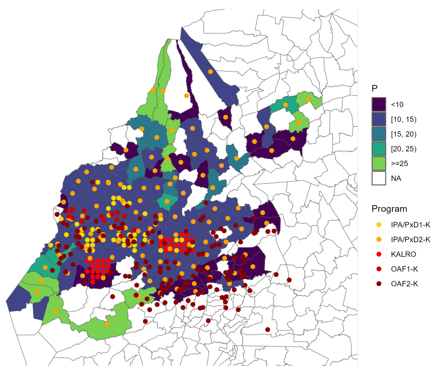
Recommendations were formulated at the ward level as it provided the most precise geographic information for farmers that could also be consistently linked to soil data. Soil data was pooled from four different sources: (i) soil data collected by IPA-K in Busia county for previous projects (Fabregas et al., 2017) in 2011 and 2014 and as part of test plot activities conducted in 2016, (ii) soil data collected by 1AF across the entire study area in 2016, (iii) soil data collected by Mumias Sugar Company in Busia and Kakamega counties between 2009 and 2016, (iv) soil data collected by the German Agro Action (Welthungerhilfe) in Kakamega and

Siaya counties in 2015. Data collected before 2014 was dropped if at least 30 more recent observations in the ward were available. The final soil dataset included about 7,085 observations for 108 wards.

1AF. To generate local recommendations, 1AF used their own soil tests conducted with soil spectroscopy, in conjunction with soil data collected in 2011 and 2014 for a previous IPA-K project (Fabregas et al., 2017). These soil chemistry results were subsequently interpolated across areas through kriging to create a continuous field of soil chemistry predictions. Since 1AF does not collect the coordinates of farmers' plots, farmers were assigned the GPS coordinates of the nearest site to which their inputs are delivered.

Optimal lime application rates for each pH level were determined based on 1AF on-farm agronomic trials conducted in 2015 (1AF, 2015). These trials involved testing three different lime application rates: 50kg/acre, 100kg/acre, and 200kg/acre. The sample was divided into pH quintiles, and for each quintile, the lime application rate that provided the most precisely estimated effect on yield was selected. Consequently, two different lime application rates were recommended, depending on the local predicted pH level: 200kg/acre and 50kg/acre. For further details on 1AF recommendations and the kriging procedure, please refer to: `https://ond3.com/lime_sms.nb.html#site-level_ph_levels`.

Figure K1: Soil Map of western Kenya



(a) Phosphorus

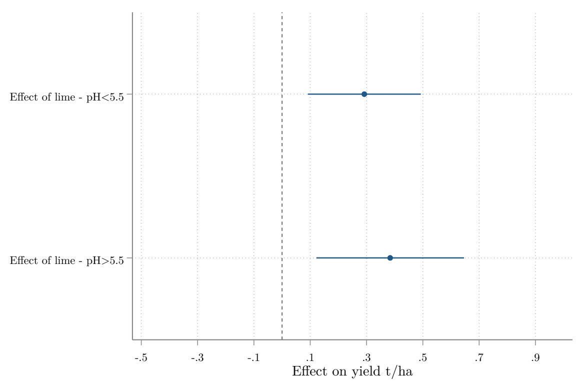
Notes: Panel (a) shows the median level of Phosphorus (P) in all wards in which the IPA/PxD2-K program took place, as well as the location of the programs.

K.2 Using Area-level Information to Generate Agricultural Advice

KALRO classifies the areas where the Kenyan projects took place as having moderate to extreme soil acidity (Kanyanjua et al., 2002). A large fraction of Rwanda's arable land is also considered acidic (Nduwumuremyi et al., 2014). However, it is also expected that heterogeneity in soil characteristics will lead to differential returns to liming for individual farmers. In particular, one consideration is the extent to which some farmers who received messages about lime might not have needed to apply the input.

First, when turning to the data, the assumption that lime has no benefits for those with a pH over 5.5 or 6 might be too strong. Using data from 1AF's experimental lime plots in Kenya, we find that, on average, liming increased maize yields even in farms that initially had pH levels above 5.5 (Appendix Figure K2). This might be because of a measurement error in soil tests or because micro-dosing lime can also make up for deficiencies of other micronutrients, like calcium.

Figure K2: Impact of Liming on Maize yields by Soil pH (1AF Agricultural Trials)



Notes: The figure shows effects of lime on maize yields from over 1AF's experimental lime plots implemented in Kenya. The figure shows heterogeneity based on whether the plots had pH values under 5.5 or over 5.5 before lime was applied.

However, even if one takes as given that a pH of 5.5, 6, or 7 is the true threshold for benefiting from lime use, an important question is how much heterogeneity there was in pH levels in the areas where lime was recommended. To speak to this issue, we use soil information from over 8,193 soil tests conducted in Kenya and 2,534 conducted in Rwanda, both from the regions where programs were implemented and lime was recommended. To the extent that these soil tests are representative of the underlying distribution of pH among farmers who took part in the programs, we can approximate the share of farmers who received lime advice and whose soils were under standard acidity thresholds.

Table K1 columns (1)-(3) report a 'naive' estimate of the fraction of soil tests taken in areas where programs recommended farmers to use lime, and that had pH levels under 5.5, 6, or 7. The majority of tests are under the acidity thresholds.

These naive estimates, however, will tend to overestimate the share of outliers in the pH distribution given measurement error in soil test measurement. Therefore, we adjust these estimates to account for measurement errors in individual soil tests.

To see this, suppose that there are locations i=1,...,N. At each location, one can observe the pH results from a soil sample tested twice q_{im}, where $m = 1, 2$ denotes measurement 1 or 2. The measurements of pH are noisy with iid errors:

$$q_{im} = Q_i + \epsilon_{im}, \quad \epsilon_{im} \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

Q_i is the true soil pH at location i and the object of interest for a farmer. With this set up, we have that $q_{im} \mid Q_i \sim \mathcal{N}(Q_i, \sigma_\epsilon^2)$. The true pH is generated by:

$$Q_i = \bar{Q} + \theta_i, \quad \theta_i \sim \mathcal{N}(0, \sigma_\theta^2)$$

Knowing that the test-retest correlation, r, corresponds to:

$$\begin{aligned} r &= corr(Q_i + \epsilon_{i1}, Q_i + \epsilon_{i2}) \\ &= \frac{cov(Q_i + \epsilon_{i1}, Q_i + \epsilon_{i2})}{\sqrt{var(Q_i + \epsilon_{i1}) * var(Q_i + \epsilon_{i2})}} \\ &= \frac{\sigma_\theta^2}{\sqrt{\sigma_\theta^2 + \sigma_{\epsilon_1}^2} * \sqrt{\sigma_\theta^2 + \sigma_{\epsilon_2}^2}} \end{aligned}$$

We can then estimate σ_θ^2 to get the 'true' share of soil tests with pH below 5.5, 6 or 7. In a sample of 563 soil samples blindly tested twice by the National Soil Laboratory in Kenya, we estimate r to be 0.74 for soil pH (Fabregas et al., 2020). Assuming that this test-retest correlation is representative for all soil tests in the sample, we can then estimate σ^2_θ for all programs. With this correction, we estimate that 96% of soils in the areas where lime was recommended were under a pH of 6 and 68% had a pH below 5.5 (Table K1 columns (5)-(7)).

Table K1: Share of acidic soil tests in areas where lime was recommended

Trial	No. soil tests	Naive share			Adjusted share		
		pH<5.5	pH<6	pH<7	pH<5.5	pH<6	pH<7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
KALRO	632	0.83	0.98	0.99	0.84	1.00	1.00
IPA/PxD1-K	2799	0.77	0.95	1.00	0.81	0.99	1.00
IPA/PxD2-K	6234	0.77	0.95	1.00	0.81	0.99	1.00
1AF1-K	703	0.78	0.97	1.00	0.86	1.00	1.00
1AF2-K	4186	0.77	0.94	1.00	0.79	0.99	1.00
1AF3-R	2318	0.51	0.77	0.99	0.52	0.88	1.00
Pooled Sample	9213	0.68	0.90	1.00	0.68	0.96	1.00

Notes: KALRO recommended farmers to use lime only after testing their own soil. Soil tests can overlap between different trials. In total, projects had access to data from 8,061 soil tests in Kenya and 2,318 in Rwanda. The source of all soil test data is discussed in Appendix section K.1.

We also assess what the differential costs of realizing low returns from lime would have been between those in the treatment and control groups. One natural hesitation in providing farmers information about lime is that if too much is applied, it could make soil pH levels alkaline. In the context of these experiments, which mostly recommended microdosing rather than broadcasting, this was highly unlikely. A meta-analysis of lime trials indicates that 2.8 tons/ha of lime increased soil pH by only 0.57 units (Hijbeek et al., 2021). Micro-dosing lime, which involves applying small amounts of lime around the planting area at rates of about 0.5 tons/ha, is therefore unlikely to sufficiently raise pH to turn the soil alakaline, even in soils with low or no acidity. In fact, one of the rationales of microdosing is that it allowed farmers to experiment with smaller quantities of the input before making substantial use of the product.

Of course, a second consideration is that some farmers might have not realized any yield benefits from using the input. Lime, however, is very cheap. At the time, the price per kg of lime in Kenya was $0.13 USD, corresponding to an average difference in expenditures between treatment and control farmers of approximately $0.15 (using the meta-analytic result from Table 3, row 19. Using the estimates from the pooled regression, this difference is approximately $0.11). Conditional on applying lime, the mean amount purchased by farmers in the pooled sample was 52 kg (median 40 kg) but the difference in purchases between treatment and control groups is only 1.37 kg, corresponding to a difference of $0.18. The point estimates of the differential quantities purchased between treated and control top lime buyers (those who bought 100 kg or more) are actually negative (though statistically insignificant). In all, while this assumes away time costs incurred by farmers, the differential costs in monetary expenditures are reasonably small, and arguably the risk of experimenting with lime is in line with the potential benefits of learning about the input. This is particularly relevant because the counterfactual scenario in this context did not entail farmers receiving perfectly accurate individual soil information; instead, it entailed receiving no information about this input.

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