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2 **Why don't farmers use fertilizers:**
3 **Evidence from Field Experiments in Western Kenya**
4 **(PRELIMINARY AND INCOMPLETE)**

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9
10 **Abstract**

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12 **This paper reports on randomized field experiments set up to investigate**
13 **various reasons for the low usage of fertilizer in Western Kenya.**
14 **Demonstration plots set up on farmer's farm show that the rate of return to**
15 **fertilizer is very high on average (up to 165%), but that in our sample, the**
16 **combination of fertilizer plus hybrid seed is not profitable on average or for**
17 **the median farmer. Farmers who participated in the demonstration plots**
18 **project are on average 11% more likely to use fertilizer in the next season**
19 **than a control group. The effect fades over time, but fertilizer use remains**
20 **permanently higher in this group. In contrast, we observe no evidence of**
21 **social learning, either between neighbors or between farmers who report**
22 **sharing experience about agriculture. Finally, a program that offered**
23 **farmers the option to buy fertilizer at harvest time led to a 17% increase in**
24 **the adoption of fertilizer, an effect larger than that of a 50% subsidy offered**
25 **later in the season. This suggests that the ability to save over the course of**
26 **the agricultural cycle is a barrier to the adoption of fertilizer.**
27

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28 **1. Introduction**

29

30 This paper seeks to understand why so many people do not use fertilizer even though it appears to
31 have the potential to improve yields considerably, thus improving poor farmers' lives as well as
32 improving food security in the country.

33

34 Models of technology adoption in agriculture suggest three broad categories of explanations.
35 First, fertilizer may not be appropriate in this region, or for most of these farmers. High average
36 returns may mask substantial heterogeneity, and have low returns to many of these farmers (Suri,
37 2006). Second, it may be appropriate, but farmers either do not know it, or do not know how to
38 use fertilizer. There may be an inefficiently low level of experimentation if there are externalities
39 in learning. Finally, there is the issue of financing profitable investments. As technology
40 adoption, information acquisition and diffusion, and the financing of investments are all
41 fundamental questions in development economics, the lessons from this project have the potential
42 to extend far beyond the specific example of fertilizer.

43

44 In this project, we employ a series of randomized field trials to investigate several hypotheses that
45 might explain why farmers do not use fertilizer: fertilizer is not profitable given the conditions on
46 real farms; it is profitable but farmers do not know how to use it, or do not know how profitable it
47 is; or, farmers have difficulty financing the investment, perhaps because they are unable to save
48 over the span of a season.

49

50 In a series of randomized field experiments, we have explored these three hypotheses. Our main
51 results suggest that: (1) fertilizer is profitable, but the rates of returns are indeed variable, and the
52 officially recommended package (hybrid seeds plus fertilizer) is not profitable; (2) providing
53 information goes part of the way towards increasing fertilizer adoption, and part of the low
54 fertilizer adoption may be explained by the complete absence of diffusion of technological
55 innovation; but (3) programs that help the farmers commit at the point where they have money to
56 use fertilizer later in the season also have a large impact on future fertilizer adoption.

57

58 This project has taken place in Busia, a relatively poor rural district in Western Kenya. The
59 majority of Busia district is classified as a moist mid-altitude agro-ecological zone and maize is
60 the main staple food. Soil fertility is low and the Kenyan Agricultural Research Institute and
61 Ministry of Agriculture recommend use of fertilizer.

62

63 Since the summer of 2000, International Child Support (ICS), a Dutch Non-Governmental
64 Organization which has been working in Busia District for ten years, has conducted a series of
65 small-scale pilot programs in order to understand the barriers to fertilizer adoption for farmers
66 growing maize. In order to evaluate the impact of these programs, beneficiaries were randomly
67 selected and data was collected. While the experiments and the data collection have already been
68 completed, the data analysis is currently ongoing; this paper presents the experiments and the
69 results that have been obtained so far, as well as some open questions.

70

71 **2. Background on maize in Kenya**

72

73 Although a relatively new crop, the production of maize has expanded so fast that maize has
74 become the dominant food crop in most of Eastern and Southern Africa. In Kenya, maize
75 accounts for 80% of cereals production (Hassan 1998, p.164) and 40% of calorie consumption
76 Kenyans consume more than 125 kilograms of maize per person per year (Byerlee, 1997 p.16).
77 There are two agricultural season, the “long rains”, and the “short rains”. The long rain
78 season is the main agricultural season, and the adoption of both hybrid seeds and
79 fertilizer is higher in that season.

80

81 Maize has been subject to technological improvements such as the use of fertilizer and new
82 hybrid seeds. In developing countries outside of Africa, the use of fertilizer accounted for 50-
83 75% increase in the crop yields from the mid 1960s (Viyas, 1983). Many believed that this new
84 technology in maize production with its high-yield potential would lead Africa to replicate the
85 success of Asia’s Green Revolution. However, this hope did not materialize. Fertilizer use in
86 Africa is still very low and has been stagnating since the 1980s.

87

88

89 In rural Western Kenya, the Ministry of Agriculture recommends the use of hybrid seeds and
90 fertilizer to increase maize yields. This recommendation is based on evidence from experimental
91 farms that fertilizer substantially increases yield on average. Those field trials report yield
92 increases of 40% to 100% on average with the use of hybrid (Suri, 2006).

93

94 However, according to surveys we have conducted in this project, just 31.1% of farmers had ever
95 used fertilizer, and just 17.4% had used fertilizer in the year prior to the survey. Switches in and
96 out of fertilizer are frequent also observed by Suri (2006). Suri (2006) uses data from a
97 panel data set covering the years 1997-2004 and several regions of Kenya, and focuses on
98 the adoption of hybrid seeds and the yield increase. She finds that adoption varies across
99 regions and across wealth quintiles. While aggregate level of use are stable over time,
100 30% of farmers in her data either stop or start using hybrid send in any given season. She
101 estimates a model with heterogenous returns to the use of hybrid seeds. Surprisingly, she
102 finds that those who would have the larger use to using fertilizer are those who appear in
103 her data as never-adopters. Those who adopt have average return close to zero, and those
104 who swith into or out of fertilizer have the lowest rates. This suggests that there are
105 constraints other than the rates of returns that constrain farmers' behavior. She explains
106 the lack of use among the farmers who have high return but do not adopt by the lack lack
107 of access to distribution channels. Over her sample period, the access to hybrid seeds was
108 constrained. However, this market is now open, and fertilizer and hybrid seeds were
109 easily accessible in our study region during the period of the study.

110

111

112

113 **A. Is fertilizer profitable?**

114

115 A natural hypothesis to explain the low level of adoption of fertilizer is that it is not a profitable
116 investment for the average farmer. While agricultural experts have found that fertilizer greatly
117 increases yields in test plots, it may not be profitable if it requires substantial investment in
118 complementary inputs, is difficult to use in real-world situations, or cannot easily be used by
119 typical farmers. For example, Foster and Rosenzweig (1995) found that uneducated farmers have
120 negative profits in the first year they adopted HYV seeds. Beginning in the July, 2000, a series of
121 6 pilot projects (over 3 years) were designed to ascertain the profitability of fertilizer on real farms
122 facing the same conditions as those experienced by local farmers.

123

124 ICS first randomly selected 30 farmers from a list of parents of students enrolled at local schools.²

² Comprehensive lists of households of this area are not available but fertility and primary school enrollment rates in this area are both high, so while this sample should be close to representative of households with

125 On each farm, an ICS field officer measured 3 adjacent 30 square meter plots (this is a very small
126 fraction of a typical farm), which were randomly assigned to one of three treatments. The first
127 plot received Calcium Ammonium Nitrate (CAN) fertilizer as top dressing (when the plant is
128 knee high). On the second plot, hybrid seeds were used in place of traditional varieties and Di-
129 Ammonium Phosphate (DAP) fertilizer was supplied for planting along with CAN for top
130 dressing. The latter combination is the full treatment recommended by the Ministry of
131 Agriculture. The third plot was a comparison plot on which farmers farmed as usual with
132 traditional seeds and with no fertilizer. ICS paid for the cost of the extra inputs (fertilizer and
133 hybrid seed) and ICS field workers applied fertilizer and seeds with the farmers, followed the
134 farmers throughout the growing season, harvested with them, and weighed the maize yield from
135 each plot.³ Aside from these visits, the farmers were instructed to farm their plots just as they
136 would have otherwise. Interviews with the farmers and field observation suggest that they did
137 this.

138

139 There were some differences in the trials from season to season. After the second, ICS stopped
140 using full treatment, and the amount of top dressing fertilizer used per hole varied from season to
141 season. Most notably, some pilots used ½ teaspoon per hole, and others used 1 teaspoon, since the
142 Kenya Agricultural Research Institute recommends 1 teaspoon per hole (KARI, 2000), while
143 other authorities recommend ½ teaspoons or even less (Salasya, et al., 1998; Ouma, et al., 2002).
144 In the fifth and sixth pilots, different quantities of fertilizer were used on different plots. The size
145 of the demonstration plots also varied from pilot to pilot.

146

147 Sample sizes ranged from 29 to 97 farmers. Surveys suggest that there were no differences in
148 farmer-provided inputs, including labor inputs, such as time spent weeding, between the plots.

149

150 Table 1 presents the mean and median rate of return obtained for each farmer by taking the
151 difference between the value of the output on the treated plot and the comparison plot, and
152 dividing by the cost of the inputs.

153

school-age children in the area. To the extent that children from poorer households are more likely to drop out, these households will be underrepresented.

³ After maize is harvested, it must be dried and shelled, and the kernels must be left to dry for several days before it is ready for consumption or sale. In later pilots, we determined the amount of weight lost as the maize dries by offering farmers incentives to carefully dry their harvested maize at their home. Enumerators then returned to measure the weight of the dried kernels and the ratio of the weight of the dry kernels to the weight at harvest and used these figures to calculate estimates for the earlier pilots

154 The price of maize fluctuates for two output prices, 25 Kenyan shilling (Ksh) per goro/goro (a
155 volume measurement which is used for measuring maize at the market), which is the average
156 price at harvest, and 40 Ksh per goro/goro which is the average maximum price over the season.
157 These figures are based on local prices during the three years ICS has been collecting data, but
158 these numbers are consistent with a much longer historical time series of prices in Nairobi and in
159 cities closer to Busia.

160

161 Even at the conservative estimate of 25 Ksh per goro-goro fertilizer yields an average return of
162 100% over one year. The 40Ksh valuation leads to an annual rate of return of 165%.

163

164 In contrast, in our sample, combining fertilizer and hybrid seeds, as recommended by the
165 Ministry of Agriculture is actually unprofitable on average. Largely because in many
166 circumstances the seeds have not germinated, causing a complete failure (in contrast, recall that
167 top dressing is applied only after seeds have germinated). Moreover, the rate of return to 1
168 teaspoon of top dressing fertilizer is consistently less profitable than $\frac{1}{2}$ teaspoon, which suggests
169 that an important part of the learning process is the amount of fertilizer to be used. This suggests
170 that Jovanovic and Nyarko's (1996) target input model of technology adoption, which is also the
171 model employed by Foster and Rosenzweig (1995) is a good framework to model learning and
172 adoption. This is an environment in which learning *how* to use fertilizer may be as important as
173 learning about rates of return, and therefore an environment where we could see learning by doing
174 as well as learning from others. There is also considerable variability in the rate of returns to
175 fertilizer across farmers within a season. This could reflect both the role of risk, as well as the
176 heterogeneity in the rates of returns across farmers (emphasized by Suri (2006)). Interestingly,
177 this variability does not seem related to observable characteristics.

178

179 **B. Learning**

180

181 The extent to which people learn from experience as well as from each other is a central question
182 in development economics. In particular, the diffusion of new technologies through social
183 networks (neighbors, friends, etc.) has been and continues to be intensively studied (see Munshi
184 (2005) for a recent review of the work in the area). The impact of learning on technology
185 adoption in agriculture has been studied particularly extensively. Besley and Case (1994) show
186 that in India, adoption of HYV seeds by an individual is correlated with adoption among their
187 neighbors. While this could be due to social learning, it could also be the case that common

188 unobservable variables affect adoption of both the neighbors. To partially address this problem,
189 Foster and Rosenzweig (1995) focus on profitability. During the early years of the green
190 revolution, returns to HYV were uncertain and dependent on adequate use of fertilizer. In this
191 context, the paper shows that profitability of HYV seeds increased with past experimentation, by
192 either the farmers or others in the village. Farmers do not fully take this externality into account,
193 and there is therefore underinvestment. In this environment, the diffusion of a new technology
194 will be slow if one neighbors' outcomes are not informative about an individual's own conditions.
195 Indeed, Munshi (2003) shows that in India, HYV rice, which is characterized by much more
196 varied conditions, displayed much less social learning than HYV wheat.

197

198 All these results could still be biased in the presence of spatially correlated profitability shocks.
199 Using detailed information about social interactions, Conley and Udry (2005) distinguish
200 geographical neighbors from “information neighbors”, the set of individuals from whom an
201 individual neighbor may learn about agriculture. They show that pineapple farmers in Ghana
202 imitate the choices (of fertilizer quantity) of their information neighbors when these neighbors
203 have a good shock, and move further away from these decisions when they have a bad shock.
204 Conley and Udry try to rule out that this pattern is due to correlated shocks by observing that the
205 choices made on an established crop (maize-cassava intercropping), for which there should be no
206 learning, do not exhibit the same pattern.

207

208 All these papers try to solve what Manski (1993) has called the “reflection problem”: outcomes of
209 neighbors may be correlated because they face common (unobserved) shocks, rather than because
210 they imitate each other. This problem can be solved, however, with an experimental design in
211 which part of a population is subject to a program that changes their behavior. The ideal
212 experiment to identify social learning is to exogenously affect the choice of technology of a group
213 of farmers and to follow subsequent adoption by themselves and their neighbors, or agricultural
214 contacts.

215

216 The current setup is well-suited to test the proposition that lack of information about either the
217 rate of return to fertilizer, or its proper use, discouraged the farmers from using fertilizer, as well
218 as the strength of network effects: since the farmers participating in each pilot were randomly
219 selected from the parents of a school list, participating in the trials is randomly assigned within a
220 school, and parents from the same schools that were not selected form a control group.

221 Moreover, by comparing those with whom the treatment farmers report talking to about

222 agriculture to those with whom the comparison farmers report talking to, we can experimentally
223 investigate whether knowledge is transmitted within networks.

224

225 **B1. The demonstration plots as agricultural extension**

226

227 The demonstration plots can be thought of as a particularly intense form of agricultural extension.
228 After the harvest, and ICS field officer discussed the results of the experiment in detail with each
229 farmer, and helped him to work through a calculation of costs and benefits of using fertilizer,
230 using his own data as well as the data for all the farmers who participated in the trials. If the
231 farmers lacked information either about costs or about the proper way to use fertilizer, this
232 intervention should have provided that to them.⁴

233

234 After each pilot, we have been following each farmer to see if he chose to use fertilizer or any
235 other inputs on his own in subsequent seasons. Table 2 presents the results. Panel A presents the
236 adoption results for all the farmers involved in the six trials, the season immediately after and in
237 the next seasons. The data is pooled across all pilots, and all the regressions control for a dummy
238 for the school the farmer belong to (since randomization was stratified within school). The
239 sample varies across columns, since the number of times a farmer was observed after the initial
240 trial depends on when the trial was conducted. The results are presented for up to 5 seasons
241 following the pilot (although the set of farmers for whom we have data is different for different
242 duration after the trial). Adoption is 10.7 percentage points (or 66%) higher the season after the
243 pilot. This effect is statistically significant, and does not represent a trivial increase. The increase
244 in adoption the season after the pilot is larger for farmers who had use fertilizer at any point in the
245 past. It is also larger for farmers who had the highest rate of return. This last result is not
246 necessarily the causal effect of high realized rates of returns, since unobserved heterogeneity may
247 explain both why a farmers had better results on the demonstration plots and why they are more
248 likely to use fertilizer in the next season. When we regress the rate of returns that farmers
249 experienced on the demonstration plots on observable characteristics, however, we find no
250 relationship. Unless unobserved farming ability is not correlated with any of these variables
251 (something which is contradicted by the findings in Suri (2006), which finds that the yield
252 increase associated with hybrid seeds is larger for educated farmers, for example) this suggest
253 that rates of return on the demonstration plots was in larger part determined by exogenous factors

⁴ We have collected data on farmers' belief about fertilizer costs and benefits both in treatment and comparison groups. The analysis of this data is not yet complete, however.

254 than by unobserved ability. In this case, the larger increase due to larger return suggest some
255 learning from individual experience.

256

257 In the season after the trial, however, only 27% of the farmers, on average use fertilizer. This
258 does suggest that lack of know-how is not the only barrier to the adoption of fertilizer. Moreover,
259 there are considerable fluctuations in and out of fertilizer use even after the trials. 39% of the
260 farmers who used fertilizer the season after participating in the demonstration plots did not use it
261 the next season. 13% of those who did not use fertilizer the season after the trials used it the next
262 season. Panel B restricts the sample to farmers that are observed in the three seasons following
263 the trials and investigates whether the effect of participating in a trial declines over time. In this
264 sample, the effect in the season after the trial was initially larger than in the larger sample (17%),
265 but declines the season after (to 11%), and seems to remain stable thereafter (at 11%).

266

267 **B.2 Learning by doing**

268

269 The trials gave the farmers the opportunity to experiment with fertilizer in their own farm, but it
270 also provided them with additional inputs: the fertilizer was applied with an ICS field officer,
271 who also visited the farmers regularly, and who helped them compute their rate of return and
272 gave information on results obtained by others at the end of the intervention. To distinguish the
273 effect of learning by doing from the effect of the additional information provided, ICS
274 implemented two separate programs in different samples.

275

276 The first program was designed to evaluate the impact of learning by doing. In this program, each
277 farmer was provided with a “starter kit”, consisting of a small quantity of fertilizer or fertilizer
278 and hybrid seeds (for a sub-sample) sufficient for a 30-square-meter plot. Farmers were instructed
279 that the kit was sufficient for this amount of space, and were given twine to measure two plots of
280 the relevant size. Beyond this, there was no monitoring of whether or not (and how) the farmers
281 used the starter kit. Starter kits have been used elsewhere; for instance, the Malawian government
282 distributed 2.86 million such packs beginning in 1998 (Masters et al., 2000). In the ICS program,
283 field staff explained how to use the inputs but did not formally monitor or measure the yields.

284

285 Starter kits were distributed to over 400 farmers randomly selected within 20 schools, in three
286 seasons. Their impact on the adoption of fertilizer or other seeds were evaluated for this entire
287 sample in the two seasons following the pilot. The results are presented in table 3. Starter kits

288 cause a significant increase in fertilizer adoption in the following season, although the effect is
289 about half the size of the own farm trial (5 percentage point), and does not persist in the following
290 year. It is also worth noting that the starter kits caused as large an increase in fertilizer use (over
291 and above the starter kit itself) beyond the starter kits *in the season in which they were*
292 *distributed* than in the next season. This cannot be due to learning by doing, since the farmers had
293 not had a chance to experience the yield increase. We will return to this puzzle below.

294

295 **B.3 Learning by Watching**

296

297 The other component of the agricultural trial was regular contact with a field officer who
298 demonstrated how to use fertilizer, and guided the farmers through a computation of the rate of
299 returns for themselves and for other farmers in the same area. To evaluate the impact of this
300 component, and to separate it from the effect of experimenting in one's own farm, in three of the
301 trials, ICS asked the farmer to name 3 people with whom they regularly discuss agriculture. In
302 two of the trials, they then invited one farmer randomly selected from this set to the key stages of
303 the trial (notably, planting, harvest, and the discussion of profitability). In the third trials, they
304 invited all the friends named by the farmer.

305

306 The impact on subsequent adoption of fertilizer amongst these farmers is presented in Table 4.
307 The first two columns compare the adoption of fertilizer of the farmers who were invited to watch
308 the trial on their friend's farm to adoption among other contacts of the pilots and contacts of the
309 comparison farmers (we also include a dummy for being a friend of the pilot, but not having been
310 invited to the trials; we will discuss this variable below). After one season, adoption of fertilizer
311 treatment is 9 percentage points higher in the first group. This suggests that the effect of being
312 invited to watch a demonstration on someone else's plot is as large as the effect of experimenting
313 on one's own plot. It is possible to learn from others. Note that not all farmers who were invited
314 actually came to the trials. If there are no large direct effect on future adoption of being invited
315 even for those who did not go, this suggest an even larger effect of watching the trials for farmers
316 who chose to attend: the IV estimates are presented in panel B, and suggest that for those who
317 decided to come to the trial, the effect of watching the trial is 21%. While these are overestimates
318 to the extent that the very fact of being invited may have had a direct impact even for those who
319 decide not to attend (in particular, this may prompt a conversation on fertilizer between the
320 farmer and his or her friend), it is sensible that the effects are indeed larger for those who chose to

321 participate, since those who decided to come were probably those who were interested to learn in
322 the first place.

323

324 Since these results suggest that learning from experience in another field is possible, ICS set up a
325 school-based demonstration intervention, which would make it possible to replicate this
326 experience on a larger scale. They randomly selected 8 of 16 schools for this treatment. In those 8
327 schools, they selected one grade, and they invited all the parents to participate on a demonstration
328 plot on the school ground (schools have typically space to grow a small maize farm). The
329 demonstration followed the same protocol as the demonstration on the pilot farm: 2 plots were
330 set up (though they were larger than the previous demonstration plots), and one of them received
331 fertilizer, while the other was left as a control plot. Parents of this grade, and of one randomly
332 selected grade in comparison, also received a starter kit at the beginning of the next season.

333

334 The results on these experimental plots were disappointing, however. Parents and children are
335 responsible for maintaining the school's farm. But in many cases, the maize was not properly
336 taken care of, and in some plots the crop was entirely destroyed (by animals) or stolen. Even in
337 plots that were harvested, the overall yield, and consequently the returns to fertilizer were low. As
338 a result, the plots had negative returns for most of the 8 plots. At the post-harvest de-briefing,
339 parents were told that the returns on their plot and that of the other school in this season were
340 negative, and that other trials conducted in the area had shown positive results.

341

342 In the next season, ICS field officers collected adoption data among the parents of these schools.
343 The results are shown in table 5, column 1: parents who have a child in class selected for the
344 demonstration plot are actually *less* likely to adopt fertilizer than those who are not. Given the
345 low performance of the treatment plots, the fact that the coefficient is insignificant and the point
346 estimate is negative is actually reassuring: it suggests that the increased adoption in response to
347 the pilot was actually the result of them updating their belief about fertilizer in response to a
348 positive experience. In contrast they do not update positively, and may be even update negatively,
349 in response to a negative experience.⁵ This is consistent with the earlier results, suggesting that
350 farmers who did well on the plots where fertilizer was used were more likely to use fertilizer after
351 the pilot.

352

⁵ We have actually collected extensive data on belief regarding the cost and benefits of fertilizer, before and after the experiments. These will be analyzed in the next draft.

353 This also suggest that while agricultural trials may be effective in diffusing information, on-farm
354 agricultural trials are expensive, while community based trials may not deliver expected results,
355 due to the public good problem involved with properly maintaining the plots. This implies that,
356 while farmer can learn from them, trials may not be a cost effective way to diffuse information
357 about technology, unless these technologies diffuses rapidly once it is introduced. This is what we
358 turn to now.

359

360 **B.4 Learning from others**

361

362 We studied diffusion, by following both the neighbors (geographical network) and the people
363 named as agricultural contacts (actual network) of the pilot and the comparison farmers. As we
364 discussed, diffusion of agricultural technology has been a focus of much attention in previous
365 literature, but this setup allows us to provide experimental evidence that does not suffer from
366 omitted variable or simultaneity bias.

367

368 Table 6 shows the results for agricultural contacts (panel A) and neighbors (panel B). The second
369 row in table 4, panel A, also show similar results⁶ In each of these panels, we compare the
370 friends (or the neighbors) of the pilot farmers with the friends (or the neighbors) of the
371 comparison farmers. Panel A shows no evidence of the diffusion of the use of fertilizer: The
372 difference between the friends of the pilot farmers and the friends of the comparison farmers is
373 only 1.7%. the standard errors are large enough to reject a 7 percentage point increase, which is
374 smaller than the effect we found on own farmer or on the “invited friends”. Panel B’s result
375 suggests that the same is true for neighbors. The point estimates are actually slightly negative,
376 though they are not significantly different from zero. Since these experiments took place early on
377 in the project, these friends and neighbors are followed up over a long period of time. But it does
378 not appear that even after 4 seasons and later, there is any impact of being a friend or a pilot of a
379 neighbor on adoption. In fact, even pooling the data across years, which generates a large sample
380 and smaller standard errors (we cluster the standard error at the farmer level since we observe the
381 same farmers several times), the result remain really close to zero and insignificant.

382

383 These results do suggest that farmers do not discuss much about agriculture: if they did, they
384 would probably be able to learn from each other’s experience, as the other experiments show. To

⁶ The only difference between Panel A of table 6 and panel A of table 3 is that the sample is restricted to friends who were not invited to the trials.

385 verify this, we interviewed farmers about their neighbors and cross-checked their answers.
386 Indeed, there seems to be considerable uncertainty regarding the activities of the neighbors: 39%
387 farmers agree about whose harvest was better. Only 46% of farmers correctly state when their
388 neighbor planted. Pilot farmers and their neighbors do not have more accurate information about
389 each other than comparison farmers and their neighbors

390

391 Overall, what may be surprising about these effects is that all the learning effects are fairly small:
392 adoption increases from 18% to 28% the season after a pilot conducted in one's own farm, from
393 18% to 23% after experimenting with a starter kit, . There is no diffusion to the neighbors and the
394 people that the farmers talk to about agriculture, though we have shown that this does not stem
395 from an inability to learn from another plot (since the effect of being invited to watch a
396 demonstration on someone else's plot is as large as the effect of doing the demonstration on one's
397 own plot). It seems that something else is preventing farmers to adopt fertilizer.

398

399

400 **C. Savings, Commitment, and Reminders**

401

402

403 These results suggest that knowledge both about how to use fertilizer and the returns to fertilizer
404 are a factor in future adoption. However, even after participating in the experiment, more than
405 half the farmers do not use fertilizer. A possible explanation is that farmers are unable to save the
406 money they need to buy fertilizer, despite their desire to do so. This suggests that a savings
407 mechanism in which to hold their money could help them invest in agricultural inputs. To
408 explore this issue, ICS set up the Savings and Fertilizer Initiative (SAFI) in 2001, a program
409 which offers to farmers who wanted to use fertilizer the ability to buy it right after harvest.

410

411 The main idea behind the SAFI program is that farmers would like to use fertilizer, but do not
412 have the money on hand when fertilizer is needed (at planting or top dressing, several week after
413 harvest). The general principle of the SAFI program is that the farmer is visited right after
414 harvest (when maize and, potentially, money is relatively plentiful), and is offered the option of
415 purchasing a voucher for fertilizer. ICS then delivers the fertilizer at the time of planting. The
416 first step was to conduct a series of small pilot programs, which were combined with the
417 demonstration plot programs. The programs showed that, among farmers who had participated to
418 the pilot program, many were indeed interested in purchasing fertilizer right after harvest, citing

419 the difficulty to save money until the time were fertilizer is needed as their main reason to be
420 interested in the program.

421

422

423 *CI. Experimental Design*

424

425 The results from the different take up in the pilot suggest that SAFI was successful in
426 encouraging fertilizer adoption. However, the samples in the different versions of SAFI were
427 small and not necessarily comparable. We therefore set up, in conjunction with ICS, a large scale
428 SAFI experiment conducted over two seasons, to evaluate the impact of a SAFI program
429 conducted on a large scale, and to tests key hypotheses helping us to understand the impact of the
430 program.

431

432 The questions and hypotheses the experiments set out to answer or test were as follows, First, the
433 main hypothesis is that SAFI leads to higher adoption because of the *timing* at which people are
434 offered to buy fertilizer, not only because, by offering to deliver fertilizer at home, the NGO is
435 strongly endorsing fertilizer or because the free deliver was convenient. And is timing is what
436 matter, how does the elasticity of fertilizer purchase compare to that with respect to price?

437

438 Second, there are some questions which have to do with the design of SAFI: is SAFI more
439 valuable to the farmer when he as cash on hands? Does it vary if people can chose in advance the
440 timing at which the offer should be made: are they sophisticated enough to request an early visit,
441 rather than a late visit if they are asked in advance which date to chose for a SAFI visit?

442

443 In order to answer this question, we set up a two-year large scale SAFI experiment in the 16
444 schools that form the treatment and the control for the school based demonstration program. The
445 experiment started in the season following the demonstration plots experiment. In this season (the
446 2004 Long Rains), a SAFI program was offered to 244 farmers after stratifying by school and
447 class (i.e. whether or not the farmer received a starter kit). Farmers were visited right after
448 harvest, and were offered the option of buying a voucher for fertilizer at the time of the visit.
449 They were free to set the date at which they wanted the fertilizer to be delivered, and exchanged
450 for the voucher. The voucher could not be exchanged for money, but delivery of fertilizer was on
451 demand, and could be changed.

452

453 In the following season (the 2004 Short Rains), the experimental design was set up to allow us to
454 test a variety of hypotheses. .

455

456 First, to study the impact of the availability of liquidity on the purchase of fertilizer, a set of
457 farmers was asked to sell some maize at an increased price (“buy” condition)

458 SAFI was then offered to randomly selected farmers, stratifying by school, starter kit status, prior
459 SAFI status, and “buy” status. Second, two variants of SAFI were offered:

- 460 • No choice condition: the farmer must buy a voucher immediately if he wishes to
461 participate (offered at harvest time)
- 462 • Choice condition: the farmer can decide *before harvest* when he would like the field
463 officer to come back to offer the SAFI. The farmer could request that the field officer
464 return at harvest, at planting, or at top dressing time. This condition was set up to test
465 whether farmers are sophisticated in their decision of purchasing fertilizer (and program
466 it in advance), .

467 In total, 417 farmers were offered SAFI in this program.

468

469 In addition, a set of farmers that were not sampled for SAFI were visited at planting time during
470 the same (2004 Short Rains) season. These farmers were sampled using the same stratified
471 sampling method as for SAFI and were offered fertilizer either at full price (but with free
472 delivery) or at half price. Thus those offered fertilizer at full price were saved travel costs and
473 were offered an implicit “endorsement” of fertilizer usage, while those offered fertilizer at half
474 price were offered these incentives plus a subsidy on the price. Use of fertilizer was followed in
475 the years following this experiment.

476

477 ***C2.2 Results: Take up of the program***

478

479 The main results concerning the take up of these interventions are summarized in Table 8. The
480 average take up in the “visit” group (those offered fertilizer at planting time at full price) was
481 21%; that is, 21% of those visited at planting did buy fertilizer for planting. The average take up
482 in the 50% “subsidy” group was 46.2%. The average take up in the SAFI group was 39.8%. The
483 difference in take-up between those offered fertilizer at full price and the SAFI and subsidy
484 groups is significant, but the average difference between SAFI and the 50% subsidy is not. This
485 suggests that SAFI increases fertilizer purchase over and above “endorsement” and

486 “convenience,” and that its effect on purchase of fertilizer is roughly equivalent to that of a 50%
487 subsidy.

488

489 This result confirms that the timing of the SAFI offer is central to its adoption. One more result is
490 important to understand the role that the offer of buying fertilizer at this particular moment for the
491 farmer means: in the group that was asked before the harvest (in the lean season) whether and
492 when the field officer should come back to sell them fertilizer, and if when at what time, the
493 eventual purchase of fertilizer was *as large* as in the group that did not have the choice. This is
494 because a large fraction of farmers (46.8%) in the choice condition asked the field officer to come
495 back immediately after harvest. This suggest that the decision to buy fertilizer when the farmers
496 were “flush with cash” do not correspond to an impulse purchased prompted by the cue given by
497 the field officer. If this were the case and fertilizer were not purchase that the farmer knows they
498 would want to make, when visited before harvest they would ask the field officer to come back at
499 planting, and would end up not purchasing fertilizer. In fact, they ask them to come early, and
500 they do buy fertilizer when they come. This also suggests that farmers are aware of their time
501 inconsistency problem and, when given the choice, impose enough constraints to arrive at the
502 same final result as when not given the choice. This result is different from the results obtained by
503 Ariely and Wertenbroch (2003) who finds that students left to chose assignments deadline do not
504 chose deadlines that are optimal from the point of view of maximizing the performance on those
505 assignments. However, note that farmers here could only chose between two dates, and it is quite
506 possible that if they could freely chose the date, as in their set up, they would also chose a date
507 that is “too late”.

508

509 Another important result, which goes in the same direction, is the lack of difference in take up in
510 the two groups where the farmers had cash on hands (because they were asked to sell some maize
511 for the experiment). Contrary to what was observed in the smaller pilots, farmers were no more
512 likely (in fact marginally *less* likely) to purchase fertilizer right after they had sold maize. This
513 does suggest that their decision to purchase maize under SAFI is not only taking an opportunity to
514 get rid of extra liquid resources.

515

516 ***C2.3 Results: Adoption of fertilizer***

517

518 A major advantage of this experimental set up (unlike, for example many experiments conducted
519 on 401k or IRA) is that we are able to evaluate the impact of the program on the final decision of

520 interest (did the farmer use fertilizer). We can thus measure the extent to which the farmers who
521 purchased fertilizer under the program would have done it anyway, and to what extent the
522 take up is a substitution effect, and also to what extent those who bought fertilizer did not
523 actually use it (i.e., to what extent purchasing fertilizer in advance is actually a commitment
524 device).

525

526 A detailed survey on the adoption of fertilizer by *everyone* in the family (farmers grow different
527 plots, some in common, and some for their private use, in particular in multi-wives household)
528 was conducted in three seasons in the schools where SAFI programs were implemented. In
529 this survey, when farmers who had purchased fertilizer under any of this program
530 reported not using fertilizer, we also asked them what they did with it (it had been very
531 explicit at the time of the program that the fertilizer they purchased was theirs, and they
532 could do what they wanted with it). Roughly 75% of the farmers who purchased fertilizer
533 under the program initially say that they have used any fertilizer. When the 25%
534 remaining ones are asked what they did with the fertilizer they purchased under SAFI,
535 roughly 24% of them do not remember having ever gotten fertilizer through SAFI (these
536 are only 8 farmers in total), and among the remaining ones, most report having used
537 fertilizer after all, having kept it for another season, or having used it on another crop
538 than maize. In almost no circumstance did the fertilizer spoil or was it sold or given away
539 to someone else. It therefore does look that fertilizer purchased under the SAFI program
540 is indeed used on the maize crop.

541

542 The fraction of those who purchased fertilizer at the time of planting, either at half price
543 or at reduced price, who initially said they used fertilizer is lower (68% and 61%)
544 respectively. When probed, most say that they have actually used the fertilizer.

545 Interestingly, though anecdotally, two farmers say that they did not use the fertilizer
546 because it spoiled, which is very unlikely, since it was sold just before it should be used.

547

548 Similar adoption data was collected for comparison farmers. Since there was no
549 comparable probing of whether or not the farmer really used fertilizer for comparison
550 farmers, we use in both cases the “raw”, uncorrected data (that is, if a farmer who
551 purchased fertilizer through SAFI or any other ICS program initially tells us that they did

552 not use fertilizer, we count them as not using fertilizer even if they corrected their answer
553 later on (the corrected results are presented in an appendix table, and the conclusion are
554 qualitatively very similar). The results on adoption are presented in tables 9 and 10. Since
555 not all programs took place in the same year we show in bold the coefficient in the first
556 year where we expect to see an effect. Panel A does not have control variables, while
557 panel B control for education, some indicator of wealth, and prior use of fertilizer.

558

559 Column 1 in panel A suggest that the first SAFI (where take up was about 30%) leads to
560 a net increase in fertilizer adoption of 10%. Column 2 show that the second SAFI (where
561 the take up was 40%) leads to an increase in adoption of 16%. Both suggest the same
562 level of substitution, and suggest that the SAFI program has a significant net effect. The
563 coefficients are slightly larger in the regressions with control variables: 13% and 20% for
564 the first and second SAFI seasons, respectively.

565

566 Interestingly, in column 2, we see that the point estimate of the net effect of the 50%
567 subsidy on fertilizer adoption is lower than that of SAFI, even though the take up of the
568 program was similar. This is particularly striking in the regression with control variables,
569 where the effect of SAFI on take up is 20 percentage points, and that of subsidy is 12
570 percentage points. Moreover, the impact of the full-price visit is also significant once
571 control variables are introduced, and the effect is 14 percentage points, lower than that of
572 SAFI but higher than that of subsidy. It suggests that a 50% subsidy does not have an
573 additional impact on net usage of fertilizer over the free delivery, even though twice as
574 many farmers take it up: clearly, most farmers who did take it up were infra-marginal,
575 and would have used fertilizer anyway. This is much less true of SAFI, however, which
576 seems to generate a large fraction of new adopters.

577

578 ***C2.4 Interpretation***

579

580 This could be a simple story of commitment device (such as the one told by Ashraf, Karlan and
581 Yin (2004)). There is, however, a very puzzling fact lingering in the background: the farmers are
582 asked when they want the fertilized to be delivered. In most cases, they want it right away (i.e.
583 much before they will actually use it). This is reasonable, since they may not trust ICS to

584 conserve their money for a long period of time, and fertilizer keeps well over a period of a few
585 weeks. But given this, and the fact that they seem to know their limitation, why don't they buy
586 fertilizer themselves right after harvest? It seems that a sophisticated farmer (which many seem to
587 be, as the results in the choice condition suggest) has the ability to do exactly what we did for
588 them. Yet, almost nobody (even among the people who use fertilizer) buys fertilizer in advance.

589

590 One possibility is that the farmers know they have an inconsistent time preference problem, but
591 they procrastinate dealing with it, because they have to pay a small cost today, which they may be
592 reluctant to do, precisely because they have time inconsistent time preferences. If this were the
593 case, a small discount on the price of fertilizer today, but with a strong deadline (expiring shortly
594 around harvest) would induce farmers to buy fertilizer at harvest time. We have tried this idea on
595 a pilot basis, by distributing farmers in one school coupons to buy fertilizer at a 6 shilling (15%)
596 discount. The coupons could be redeemed at any of the three stores in the villages. The take up of
597 this program was quite high, at 29.8%. This suggests that the story we just told may be right. This
598 also suggests a way to transform the SAFI program into a cost effective development
599 intervention: while it is costly and logistically difficult to visit all the farmers exactly at the time
600 of harvest, the coupons program would be relatively easy to generalize.

601

602 Another possibility is that the SAFI program simply reminds farmers that they should get
603 fertilizer now, before they run out of money later in the season. To test this hypothesis, we set up
604 a last experiment, where ICS field officer visited a sample of farmers at harvest time and
605 reminded them that buying fertilizer at harvest time is possible, and that many farmers who want
606 to use fertilizer do not end up doing it if they don't buy it at harvest time. The result are presented
607 in table 11, and suggest that reminding farmers of the time-inconsistency problem is not
608 sufficient: the point estimate effect of being reminded on actual purchase of fertilizer later in the
609 same season is actually slightly negative, and this estimate is insignificant. This is consistent with
610 the interpretation of the absence of difference between the "choice of timing" condition and the
611 "no choice" condition that many farmers seemed to be in part aware about the time-inconsistency
612 problem.

613

614 **D. Conclusion**

615

616 The problem of fertilizer adoption is both important in itself and because it embodies all the
617 problems of technology adoption that we encounter in developing countries: from computers, to

618 deworming drugs, to condoms. We have set up a series of randomized experiment to try to
619 understand the determinants of fertilizer adoption. We conclude that while information matters, it
620 only goes part of the way, and whatever information is provided seems to be forgotten fast and
621 not diffused to friends and neighbors in the mean time. Other things seem important as well, in
622 particular the ability to finance the purchase of fertilizer, which for many farmers, is synonymous
623 with the ability to buy fertilizer at the time of harvest. We have seen that if farmers are offered to
624 buy fertilizer at the time of harvest, many do, and this lead to substantial increases in adoption.
625 We are still to resolve why they do not do it themselves, and why the market is not proactively
626 seeking this opportunity.

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Table 1: Returns to Fertilizer

	Top Dressing 1/4 Teaspoon			Top Dressing 1/2 Teaspoon			Top Dressing 1 teaspoon 1 Teaspoon			Official Package Recommended by Ministry of Agriculture		
	mean	median	obs	mean	median	obs	mean	median	obs	mean	median	obs
Panel A: Not Annualized												
25 Ksh per goro-goro	0.080	-0.327	116	0.189	0.156	202	-0.476	-0.494	85	-0.476	-0.494	85
40 Ksh per goro-goro	0.728	0.077	116	0.903	0.850	202	-0.161	-0.191	85	-0.161	-0.191	85
Panel B: Annualized												
25 Ksh per goro-goro	0.362	-0.794	116	1.002	0.786	202	-0.788	-0.805	85	-0.788	-0.805	85
40 Ksh per goro-goro	1.272	0.118	116	1.625	1.515	202	-0.190	-0.225	85	-0.190	-0.225	85

Profits are calculated as the difference between the value of the extra maize on the treatment plot (relative to the comparison plot) and the cost of treatment, divided by the cost of treatment. The value of the extra maize is calculated at both the average post-harvest price (25 Ksh per goro-goro, a volume measure) and at the average price in the month where maize typically reaches its highest price (40 Ksh per goro-goro). Panel A reports the non-annualized rates of return at both prices.

Panel B annualizes the return, taking into account that the harvest takes place roughly 5 months after planting (when hybrid seeds and planting fertilizer must be applied from the Official Package) and 3 months after the application of top dressing fertilizer. To realize the peak price of 40 Ksh, the farmer must hold his maize for an additional 5 months after (the Short Rains) harvest.

Thus, the annualized rate of returns to top dressing is $(1+r)^{(12/3)}-1$ for the post-harvest price and $(1+r)^{(12/8)}-1$ for the peak price.

The annualized returns to full treatment are $(1+r)^{(12/5)}-1$ for the post-harvest price and $(1+r)^{(12/10)}-1$ for the peak price.

Table 2: Adoption for Farmers Participating in Demonstration Plot

	<i>1 season later</i>	<i>2 seasons later</i>	<i>3 seasons later</i>	<i>4 seasons later</i>	<i>5 seasons later</i>
Panel A. All Farmers	(1)	(2)	(3)	(4)	(5)
Demonstration Plot Farmer	0.107 (0.039)***	0.089 (0.044)**	0.101 (0.050)**	0.156 (0.089)*	0.229 (0.093)**
Observations	580	523	450	116	109
Panel B. Only Farmers with at least 3 seasons of Adoption Data	(1)	(2)	(3)		
Demonstration Plot Farmer	0.169 (0.050)***	0.113 (0.054)**	0.112 (0.054)**		
Observations	371	371	371		

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

Seasons are measured as the number of seasons since the Demonstration Plot Intervention

Regressions control for school.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Adoption for Farmers Offered Starter Kits

	<i>Season of the Program</i>	<i>1 season later</i>	<i>2 seasons later</i>
	(1)	(2)	(3)
Starter Kit Farmer	0.060 (0.032)*	0.051 (0.029)*	0.019 (0.029)
Observations	874	1045	1060

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

Seasons are measured as the number of seasons since the Demonstration Plot Intervention

Column (1) measures fertilizer used *apart from the starter kit itself* in the season in which the starter kit was distributed.

Sample pools individuals sampled for the School-Based Starter Kit Program and individuals sampled for the earlier starter kit trial program.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Regressions control for school.

Table 4: Adoption for Agricultural Contacts

	<i>1 season later</i>	<i>2 seasons later</i>	<i>3 seasons later</i>	<i>4 seasons later</i>	<i>5 seasons later</i>
Panel A. OLS	(1)	(2)	(3)	(4)	(5)
Invited Agricultural Contact	0.093 (0.055)*	0.031 (0.061)	-0.014 (0.058)	-0.059 (0.063)	0.026 (0.068)
Uninvited Agricultural Contact	0.002 (0.035)	-0.015 (0.038)	-0.015 (0.037)	-0.08 (0.068)	-0.132 (0.089)
Observations	708	580	557	215	177
B. Panel B: 2SLS	(1)	(2)	(3)	(4)	(5)
Came to Treatment (instrumented with Invited Agricultural Contact)	0.212 (0.127)*	0.072 (0.142)	-0.03 (0.129)	-0.123 (0.133)	0.053 (0.137)
Uninvited Agricultural Contact	-0.002 (0.037)	-0.017 (0.039)	-0.014 (0.037)	-0.082 (0.068)	-0.131 (0.088)
Observations	708	580	557	215	177
Panel C. Neighbors of Demonstration Plot Farmers	(1)	(2)	(3)	(4)	(5)
Pilot Neighbor	-0.04 (0.049)	-0.037 (0.048)	-0.023 (0.047)	-0.034 (0.055)	-0.074 (0.058)
Observations	264	383	366	247	265

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

Seasons are measured as the number of seasons since the Demonstration Plot Intervention

Invited contacts were invited to witness the application of fertilizer, to participate in the harvest, or both.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Regressions control for school.

Table 5: Adoption for Parents Sampled for School-Based Demonstration

Season	<i>Long Rains 2004</i>	<i>Short Rains 2004</i>	<i>Long Rains 2005</i>
Number of Seasons after School-Based Demonstration Plot	1	2	3
Number of Seasons after Starter Kit Program	-	1	2
Programs for which an effect would be expected in the given season (coefficients in bold)	<i>SAFI LR 2004</i> <i>Demo Plot</i>	<i>SAFI SR 04</i> <i>Subsidy</i> <i>Full Price Visit</i> <i>Starter Kit</i>	-
Panel A. Control for School	(1)	(2)	(3)
Starter Kit Farmer	0.085 (0.045)*	0.047 (0.049)	0.011 (0.045)
Sampled to Participate in School Demonstration Plot	-0.046 (0.064)	0.018 (0.071)	-0.016 (0.065)
Observations	874	752	900
Panel B. Other Controls	(1)	(2)	(3)
Starter Kit Farmer	0.093 (0.045)**	0.027 (0.047)	-0.016 (0.049)
Sampled to Participate in School Demonstration Plot	-0.075 (0.065)	-0.021 (0.069)	-0.052 (0.072)
Home has mud walls	-0.175 (0.079)**	-0.088 (0.083)	0.064 (0.086)
Home has mud floor	-0.046 (0.073)	-0.031 (0.077)	-0.127 (0.080)
Home has thatch roof	-0.034 (0.037)	0.080 (0.039)**	-0.050 (0.040)
Education primary respondent	0.009 (0.004)**	-0.004 (0.004)	0.015 (0.005)**
Gender	0.016 (0.03)	0.003 (0.03)	-0.040 (0.04)
Has household ever used fertilizer before?	0.24 (0.037)**	0.17 (0.041)**	0.08 (0.042)*
Household had used fertilizer in the 1st season after		0.390 (0.039)**	
Household had used fertilizer in the 2nd season after			0.305 (0.039)**
Observations	774	648	652

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

SAFI, Subsidy, and Full Price Visit Programs explained in text.

Coefficients in bold indicate the season in which we would expect to see an effect for the given program. For instance, the SAFI program for the Long Rains 2004 should have an effect for the 2004 Long Rains Adoption, but not directly for other seasons.

Regressions control for school.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Adoption for SBSK1 Friends

Season	<i>Long Rains 2004</i>	<i>Short Rains 2004</i>	<i>Long Rains 2005</i>
Number of Seasons after School-Based Demonstration Plot	1	2	3
Number of Seasons after Starter Kit Program	-	1	2
Programs for which an effect would be expected in the given season (coefficients in bold)	<i>SAFI LR 2004</i> <i>Demo Plot</i>	<i>SAFI SR 04</i> <i>Subsidy</i> <i>Full Price Visit</i> <i>Starter Kit</i>	-
	(1)	(2)	(3)
Friend of Starter Kit Farmer	0.086 (0.073)	0.048 (0.074)	0.115 (0.072)
Friend of Starter Kit Farmer Sampled to Participate in Demonstration Plot	-0.018 (0.105)	-0.072 (0.104)	0.011 (0.103)
Friend of SAFI Farmer for Long Rains 2004	0.000 (0.061)	0.029 (0.059)	0.112 (0.060)*
Friend of SAFI Farmer for Short Rains 2004	0.045 (0.080)	-0.011 (0.075)	0.031 (0.077)
Friend of Farmer Sampled for Subsidy Program	-0.039 (0.092)	-0.077 (0.090)	-0.005 (0.090)
Friend of Farmer Sampled for Full Price Visit	0.000 (0.094)	-0.120 (0.092)	0.059 (0.092)
Observations	370	315	387

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

SAFI, Subsidy, and Full Price Visit Programs explained in text.

Regressions control for school.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Take-up of Various Commitment Savings Products (SAFI Program)**Panel A. Pilot SAFI Programs**

		<i>Number of Farmers</i>	<i>Percentage</i>
option 1: take-it-or-leave-it	Offered SAFI	54	
	Initially accepted	30	0.56
	Actually paid	30	0.56
option 2: take-it-or-leave-it (with cash effect)	offered SAFI	49	
	initially accepted	39	0.80
	actually paid	39	0.80
option 3: return in a few days to collect the money	offered SAFI	50	
	initially accepted	35	0.70
	actually paid	15	0.30
option 4: return in a few months to collect the money	offered SAFI	71	
	initially accepted	44	0.62
	actually paid	12	0.17

Panel B. School Based SAFI Program

		<i>Number of Farmers</i>	<i>Percentage</i>
SAFI Long Rains 2004	Bought Fertilizer	74	0.31
SAFI Short Rains 2004			
Given Choice X Bought Maize	Bought Fertilizer	19	0.32
Given Choice X Didn't Buy Maize	Bought Fertilizer	66	0.44
Not Given Choice X Bought Maize	Bought Fertilizer	24	0.41
Not Given Choice X Didn't Buy Maize	Bought Fertilizer	57	0.38
<i>Total</i>	Bought Fertilizer	166	0.40
Subsidy Short Rains 2004	Bought Fertilizer	67	0.46
Full Price Visit Short Rains 2004	Bought Fertilizer	28	0.20

Table 8: Adoption for Parents Sampled for School-Based SAFI and Subsidy

Season	<i>Long Rains 2004</i>	<i>Short Rains 2004</i>	<i>Long Rains 2005</i>
Number of Seasons after School-Based Demonstration Plot	1	2	3
Number of Seasons after Starter Kit Program	-	1	2
Programs for which an effect would be expected in the given season (coefficients in bold)	<i>SAFI LR 2004</i> <i>Demo Plot</i>	<i>SAFI SR 04</i> <i>Subsidy</i> <i>Full Price Visit</i> <i>Starter Kit</i>	-
Panel A. Control for School	(1)	(2)	(3)
Starter Kit Farmer	0.085 (0.045)*	0.047 (0.049)	0.011 (0.045)
Sampled to Participate in School Demonstration Plot	-0.046 (0.064)	0.018 (0.071)	-0.016 (0.065)
SAFI Long Rains 2004	0.103 (0.038)***	-0.020 (0.043)	-0.018 (0.039)
SAFI Short Rains 2004	-0.037 -0.047	0.169 (0.053)***	-0.033 -0.048
Subsidy Short Rains 2004	-0.046 (0.056)	0.142 (0.063)**	0.024 (0.057)
Full Price Visit Short Rains 2004	-0.089 (0.056)	0.070 (0.063)	-0.064 (0.057)
Observations	874	752	900
Panel B. Other Controls	(1)	(2)	(3)
Starter Kit Farmer	0.093 (0.045)**	0.027 (0.047)	-0.016 (0.049)
Sampled to Participate in School Demonstration Plot	-0.075 (0.065)	-0.021 (0.069)	-0.052 (0.072)
SAFI Long Rains 2004	0.134 (0.038)***	-0.041 (0.041)	0.001 (0.043)
SAFI Short Rains 2004	-0.020 (0.047)	0.198 (0.051)***	-0.073 (0.054)
Subsidy Short Rains 2004	-0.077 (0.056)	0.129 (0.061)**	-0.002 (0.063)
Full Price Visit Short Rains 2004	-0.073 (0.057)	0.140 (0.062)**	-0.118 (0.064)*
Home has mud walls	-0.175 (0.079)**	-0.088 (0.08)	0.064 (0.09)
Home has mud floor	-0.046 (0.07)	-0.031 (0.08)	-0.127 (0.08)
Home has thatch roof	-0.034 (0.04)	0.080 (0.039)**	-0.050 (0.04)
Education primary respondent	0.009 (0.004)**	-0.004 (0.00)	0.015 (0.005)***
Gender	0.016 (0.032)	0.003 (0.034)	-0.040 (0.036)
Has household ever used fertilizer before?	0.239 (0.037)***	0.174 (0.041)***	0.083 (0.042)*
Household used fertilizer in 2004 Long Rains		0.390 (0.039)***	
Household used fertilizer in 2004 Short Rains			0.305 (0.039)***
Observations	774	648	652

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

SAFI, Subsidy, and Full Price Visit Programs explained in text.

Coefficients in bold indicate the season in which we would expect to see an effect for the given program. For instance, the SAFI program for the Long Rains 2004 should have an effect for the 2004 Long Rains Adoption, but not directly for other seasons.

Regressions control for school. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 9: Adoption for Parents Sampled for SAFI, Subsidy

	<i>Long Rains 2004</i>	<i>Short Rains 2004</i>	<i>Long Rains 2005</i>
Panel A. Control for School	(1)	(2)	(3)
	<i>fertilizer</i>	<i>fertilizer</i>	<i>fertilizer</i>
Starter Kit Farmer	0.097 (0.047)**	0.076 (0.051)	0.017 (0.047)
Sampled to Participate in School Demonstration Plot	-0.047 (0.064)	0.015 (0.071)	-0.016 (0.065)
SAFI Long Rains 2004	0.102 (0.038)***	-0.022 (0.043)	-0.017 (0.039)
SAFI Short Rains 2004	-0.037 (0.054)	0.149 (0.062)**	-0.034 (0.055)
Subsidy Short Rains 2004	-0.045 (0.056)	0.143 (0.063)**	0.025 (0.057)
Full Price Visit Short Rains 2004	-0.088 (0.056)	0.073 (0.063)	-0.064 (0.057)
Bought Maize for SAFI Short Rains 2004	-0.045 (0.053)	-0.109 (0.058)*	-0.025 (0.055)
Choice of Return Time for SAFI Short Rains 2004	0.026 (0.044)	0.097 (0.048)**	0.017 (0.045)
Observations	874	752	900
Panel B. Other Controls	(1)	(2)	(3)
	<i>fertilizer</i>	<i>fertilizer</i>	<i>fertilizer</i>
Starter Kit Farmer	0.112 (0.046)**	0.059 (0.049)	-0.032 (0.051)
Sampled to Participate in School Demonstration Plot	-0.074 (0.065)	-0.020 (0.069)	-0.054 (0.072)
SAFI Long Rains 2004	0.134 (0.038)***	-0.042 (0.041)	0.001 (0.043)
SAFI Short Rains 2004	0.000 (0.055)	0.206 (0.059)***	-0.075 (0.063)
Subsidy Short Rains 2004	-0.075 (0.056)	0.130 (0.061)**	-0.003 (0.063)
Full Price Visit Short Rains 2004	-0.072 (0.057)	0.144 (0.062)**	-0.121 (0.064)*
Bought Maize for SAFI Short Rains 2004	-0.080 (0.053)	-0.124 (0.057)**	0.062 (0.060)
Choice of Return Time for SAFI Short Rains 2004	0.006 (0.044)	0.052 (0.047)	-0.034 (0.049)
Home has mud walls	-0.170 (0.079)**	-0.078 (0.083)	0.057 (0.086)
Home has mud floor	-0.050 (0.073)	-0.043 (0.077)	-0.120 (0.080)
Home has thatch roof	-0.039 (0.037)	0.071 (0.039)*	-0.047 (0.040)
Education primary respondent	0.009 (0.004)**	-0.004 (0.004)	0.015 (0.005)***
Gender	0.015 (0.032)	0.003 (0.034)	-0.041 (0.036)
Has household ever used fertilizer before?	0.241 (0.037)***	0.177 (0.041)***	0.081 (0.043)*
Household had used fertilizer in the 1st season after		0.384 (0.039)***	
Household had used fertilizer in the 2nd season after			0.311 (0.039)***
Observations	774	648	652

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

SAFI, Subsidy, and Full Price Visit Programs explained in text.

Coefficients in bold indicate the season in which we would expect to see an effect for the given program. For instance, the SAFI prog for the Long Rains 2004 should have an effect for the 2004 Long Rains Adoption, but not directly for other seasons.

Regressions control for school. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 10: SAFI Reliabilities

	<i>SAFI</i> <i>Long Rains 2004</i> (1)		<i>SAFI</i> <i>Short Rains 2004</i> (2)		<i>Subsidy Visit</i> <i>Short Rains 2004</i> (3)		<i>Full Price Visit</i> <i>Short Rains 2004</i> (4)	
Of those that bought fertilizer through Program:								
Reported Using Fertilizer in Survey	53	0.746	108	0.766	39	0.684	16	0.615
Reported not Using Fertilizer in Survey	18	0.254	33	0.234	18	0.316	10	0.385
Of those that Reported Not Using Fertilizer in Survey:								
says bought from program	13	0.765	29	0.879	12	0.750	8	0.800
says didn't buy from program	4	0.235	4	0.121	4	0.250	2	0.200
What did they do with fertilizer?								
1 - gave away / sold	0	0.000	1	0.036	0	0.000	0	0.000
4 - fertilizer spoiled	2	0.125	1	0.036	2	0.167	0	0.000
5 - used on different crop	1	0.063	7	0.250	0	0.000	1	0.125
6 - kept for another season	1	0.063	9	0.321	1	0.083	2	0.250
7 - used on different plot	0	0.000	2	0.071	1	0.083	1	0.125
8 - used on maize crop	11	0.688	7	0.250	7	0.583	4	0.500
9 - other	1	0.063	1	0.036	1	0.083	0	0.000

Table 11: Reminder Intervention

Panel A. Control for School and Various Treatments	(1)	(2)	(3)
	<i>Bought Planting Fertilizer</i>	<i>Bought Top Dressing Fertilizer</i>	<i>Bought or Planned to Buy Top Dressing Fertilizer</i>
Reminder Intervention	-0.043 (0.069)	-0.035 (0.054)	0.009 (0.072)
Observations	195	196	194
Panel B. Other Controls	(1)	(2)	(3)
	<i>Bought Planting Fertilizer</i>	<i>Bought Top Dressing Fertilizer</i>	<i>Bought or Planned to Buy Top Dressing Fertilizer</i>
Demonstration Plot Farmer	-0.057 (0.079)	-0.057 (0.062)	-0.006 (0.082)
Mud Walls	0.157 (0.173)	-0.166 (0.136)	-0.089 (0.181)
Mud Floors	-0.119 (0.160)	0.039 (0.126)	0.115 (0.167)
Thatch Roof	-0.124 (0.090)	-0.06 (0.070)	-0.01 (0.093)
Education	0.017 (0.010)	0.005 (0.008)	0.012 (0.011)
Observations	160	161	159

Farmers sampled for the reminder intervention were visited at the time of top dressing and "reminded" that they could purchase fertilizer on their own from a shop in the area. No explicit endorsement of fertilizer was given.

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Regressions control for school.

Table A1: Adoption for Parents Sampled for SAFI, Subsidy with Corrected Adoption Estimates

	<i>Long Rains 2004</i>	<i>Short Rains 2004</i>	<i>Long Rains 2005</i>
Panel A. Control for School			
Starter Kit Farmer	(1) 0.086 (0.045)*	(2) 0.034 (0.050)	(3) 0.011 (0.045)
Sampled to Participate in School Demonstration Plot	-0.028 (0.065)	0.029 (0.072)	-0.016 (0.065)
SAFI Long Rains 2004	0.142 (0.038)***	-0.023 (0.043)	-0.018 (0.039)
SAFI Short Rains 2004	-0.034 -0.047	0.187 (0.054)***	-0.033 -0.048
Subsidy Short Rains 2004	-0.022 (0.056)	0.217 (0.064)***	0.024 (0.057)
Full Price Visit Short Rains 2004	-0.092 (0.056)	0.097 (0.064)	-0.064 (0.057)
Observations	874	752	900
Panel B. Other Controls			
Starter Kit Farmer	(1) 0.088 (0.045)*	(2) 0.021 (0.049)	(3) -0.016 (0.049)
Sampled to Participate in School Demonstration Plot	-0.050 (0.066)	-0.012 (0.071)	-0.052 (0.072)
SAFI Long Rains 2004	0.172 (0.039)***	-0.049 (0.042)	0.001 (0.043)
SAFI Short Rains 2004	-0.021 (0.048)	0.221 (0.053)***	-0.073 (0.054)
Subsidy Short Rains 2004	-0.063 (0.057)	0.209 (0.063)***	-0.002 (0.063)
Full Price Visit Short Rains 2004	-0.082 (0.058)	0.166 (0.064)***	-0.118 (0.064)*
Home has mud walls	-0.176 (0.080)**	-0.086 (0.09)	0.064 (0.09)
Home has mud floor	-0.038 (0.07)	-0.018 (0.08)	-0.127 (0.08)
Home has thatch roof	-0.022 (0.04)	0.064 (0.04)	-0.050 (0.04)
Education primary respondent	0.008 (0.004)**	-0.001 (0.00)	0.015 (0.005)***
Household had used fertilizer in the 1st season after	0.034 (0.033)	-0.008 (0.036)	-0.040 (0.036)
Household had used fertilizer in the 2nd season after	0.239 (0.038)***	0.165 (0.042)***	0.083 (0.042)*
Gender		0.365 (0.040)***	
Has household ever used fertilizer before?			0.305 (0.039)***
Observations	774	648	652

Dependent variable is an indicator equal to 1 if the farmer adopted planting or top dressing fertilizer in the given season.

SAFI, Subsidy, and Full Price Visit Programs explained in text.

Coefficients in bold indicate the season in which we would expect to see an effect for the given program. For instance, the SAFI program for the Long Rains 2004 should have an effect for the 2004 Long Rains Adoption, but not directly for other seasons.

Regressions control for school. Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%