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# DOES SHIFTING TO A FLEXIBLE E-VOUCHER APPROACH IMPROVE INPUT SUBSIDY PROGRAM OUTCOMES? QUASI-EXPERIMENTAL EVIDENCE FROM ZAMBIA'S CROP FORECAST SURVEYS

By

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**Food Security Policy *Research Papers***

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**ABSTRACT**

The introduction of the e-voucher approach to Zambia's input subsidy program, the Farmer Input Support Programme (FISP), was intended, *inter alia*, to improve farmers' access to and use of modern inputs; incentivize private sector investment in fertilizer and other input value chains, thereby improving the timely availability of the inputs and bringing them closer to farmers; and encourage farmers to diversify away from maize by allowing them to use the e-voucher for the farm inputs or equipment of their choosing – not just maize seed and fertilizer. This study employs a difference-in-differences approach using Crop Forecast Survey (CFS) data from before and during the 2015/16 and 2016/17 e-FISP pilot years to empirically estimate the contemporaneous effects of the shift to the e-FISP from the traditional FISP on several of these outcomes. The results suggest that the e-FISP fell short of achieving many of its objectives, at least in the short-run and based on the outcomes that could be analyzed using the CFS data. At best, the outcomes analyzed were no different (in a statistically significant way) under the e-FISP and the traditional FISP; at worst, outcomes were worse under the e-FISP. These disappointing e-FISP results are likely due more to implementation challenges and lack of political will than to fundamental flaws in the e-FISP concept and design.

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## 1. INTRODUCTION

Although modern input use is on the rise in Sub-Saharan Africa (SSA), finding cost-effective ways to increase it further as a means of reducing poverty and food insecurity remains a key policy challenge (Alliance for a Green Revolution in Africa 2016, 2019; Food & Agriculture Organization of the United Nations 2017; Sheahan & Barrett 2017). Many governments in the region use agricultural input subsidy programs (ISPs) as one of their primary strategies to achieve this goal (see, *inter alia*, Jayne & Rashid 2013, Jayne et al. 2018, and Holden 2019). In some countries, use of ISPs dates back to as early as independence in the 1960s, and the programs have come in to and out of favor in the intervening decades. A distinguishing feature of the wave of post-structural adjustment ISPs that began sweeping SSA in the early-to-mid-2000s is its (rhetorical, if not practical) emphasis on making the subsidy programs "market-smart".[1] Yet there has been little rigorous evaluation of the impacts on program effectiveness of ostensibly market-smart reforms to ISPs. The main exception is Kaiyatsa et al.'s (2018) analysis of the 2015 reform to Malawi's ISP that allowed beneficiary farmers to redeem their vouchers for subsidized fertilizer at selected private sector retailers; previously, all fertilizer for the program had to be collected from government depots.[2] The vast remaining literature on ISPs in SSA analyzes program targeting or estimates the effects of participation in an ISP on various outcomes, *holding a program's design or implementation modalities constant*. (See Jayne et al. 2018 and Holden 2019 for recent, comprehensive reviews of this literature.) This is useful and can sometimes point to potential program design or implementation changes that could increase an ISP's effectiveness, but equally important is understanding the impacts of those changes once implemented.

This study leverages a nationally- and district-representative pooled cross-sectional dataset containing nearly 53,000 household observations and quasi-experimental methods to estimate the short-run effects of a major change in the design of Zambia's ISP, the Farmer Input Support Program (FISP). This change entailed a shift in FISP from a 'traditional,' maize-centric program that distributed subsidized fertilizer and improved seed in-kind to beneficiaries through their farmers' groups, to a flexible, electronic voucher- (e-voucher-) based program through which beneficiaries redeemed e-vouchers for the subsidized agricultural inputs or equipment of their choice at private sector retailers' shops. The FISP e-voucher was piloted in 13 and 39 of Zambia's 100+ districts during the 2015/16 and 2016/17 agricultural seasons, respectively, before being rolled out nationwide in 2017/18.[3] The traditional FISP continued to be implemented in non-pilot districts in 2015/16 and 2016/17. We exploit exogenous variation in the format of FISP (traditional vs. e-voucher) to identify the effects of the shift to the e-voucher

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[1] Morris et al. (2007) outline ten criteria for market-smart fertilizer subsidies; namely, such subsidies should: (1) be part of a broader strategy to promote fertilizer use and not be viewed as a silver bullet; (2) work through the private sector and promote fertilizer market development; (3) promote competition in fertilizer markets; (4) take into consideration the profitability of fertilizer use and farmers' effective demand for fertilizer; (5) focus on areas where it is economically efficient to use fertilizer; (6) "empower farmers to make their own decisions on the most appropriate way to manage soil fertility in their particular farming context" (p. 12); (7) be temporary and have an exit strategy; (8) be implemented alongside efforts to promote regional market integration and harmonization of fertilizer policies; (9) be "economically, institutionally, and environmentally sustainable" (p. 12); and (10) "promote pro-poor growth" (p. 13).

[2] A future version of this paper will integrate the findings of Tossou and Baylis (2018), who use household panel survey data from 12 districts in Zambia to evaluate the impacts of the shift to the e-FISP on household maize yields, consumption expenditure, and food security.

[3] There were 103 districts and 10 provinces in Zambia as of 2016/17. There are 114 districts as of January 2020.

on various outcomes linked to the program's objectives (e.g., unsubsidized fertilizer purchases; access to, use of, and timely availability of modern inputs; and crop diversification).

The study therefore adds to the thin literature on the effects of ISP innovations on program outcomes, complementing Kaiyatsa et al. (2018). To our knowledge, it is also the first rigorous evaluation of Zambia's shift to a flexible e-voucher approach to FISP. While there have been a number of reports on the program's piloting and nationwide rollout (e.g., Kuteya et al. 2016; Kuteya & Chapoto 2017; Siame et al. 2017; Chibbompa 2018; Chikobola & Tembo 2018; Kasoma et al. 2018; Kuteya et al. 2018; Mulozi 2018), these reports are descriptive and do not measure the *ceteris paribus* effects of the policy change. In addition, this paper is one of only a small number of studies in the SSA ISPs literature to utilize a difference-in-differences (DD) approach;[4] the vast majority of past studies in this literature rely on panel data, matching, or instrumental variables/control function methods to identify program effects.[5]

The remainder of the paper is organized as follows. Section 2 discusses the key features of Zambia's traditional and e-voucher FISP approaches and the rollout of the latter. Section 3 summarizes the data used. Section 4 describes our empirical strategy. Section 5 presents and discusses the results, and Section 6 highlights the conclusions and policy implications.

[4] To our knowledge, the only other studies in this literature to use a DD approach are Kaiyatsa et al. (2018) and Mason et al. (2017). The latter analyzes the introduction of the National Accelerated Agricultural Inputs Access Programme (NAAIAP) on smallholder farm household crop production and incomes.
[5] See Supplemental Online Appendix B in Jayne et al. (2018) for a summary of the methods in each of nearly 80 studies on ISPs in SSA.

## 2. THE FARMER INPUT SUPPORT PROGRAM AND ITS EVOLUTION

FISP was first implemented in Zambia during the 2009/10 agricultural season, when it replaced the Fertilizer Support Program (FSP) as the country's main ISP.[6] FISP was largely similar to FSP, the main exceptions being that: (i) the FISP input pack size (100 kg each of basal and top dressing fertilizer plus 10 kg of hybrid or improved open-pollinated variety maize seed) was half as large as that under FSP; and, relatedly, (ii) the eligibility requirement that beneficiary households be able to cultivate a minimum area of maize was reduced from 1 hectare (ha) under FSP to 0.5 ha under FISP to correspond to the reduced input pack size. The other eligibility criteria for FISP were that the applicant: be an active small-scale farmer (i.e., cultivate less than 5 ha of land total); be a member of a selected, registered farmers' cooperative or other farmers' organization; be able to pay the farmer contribution for the inputs (described further below); not concurrently benefit from the Food Security Pack Program, another, much smaller government ISP targeted at poor households that do not meet the FISP eligibility criteria; and not be a defaulter from the pre-FSP credit-based ISP (Ministry of Agriculture and Cooperatives (MACO) various years; Ministry of Agriculture and Livestock (MAL) various years). Beginning in 2013/14, farmers were also required to register with the Ministry of Agriculture (MoA) in order to be eligible for FISP.[7] Farmers interested in participating in FISP apply through their farmer organization. The local Camp Agricultural Committee (CAC) then reviews these applications and selects beneficiary farmers, bearing in mind the FISP eligibility criteria.[8] Note, however, that in practice, at least prior to the e-FISP, the FISP eligibility criteria were not well enforced and many technically ineligible households nonetheless acquired inputs through FISP (Mason et al. 2013).

The overall objective of FISP is "to improve the supply and delivery of agricultural inputs to small-scale farmers through sustainable private sector participation at affordable cost, in order to increase household food security and incomes" (MAL 2013, p. 7). The main sub-objectives of the program are to "ensure timely, effective and adequate supply of agricultural inputs to targeted small-scale farmers" and to "improve access of small-scale farmers to agricultural inputs" (Ibid.).

The key features of FISP as it was implemented prior to the introduction of the e-voucher (henceforth, the 'traditional FISP') are that: (i) it focused almost exclusively on maize (with a small number of input packs for a handful of other crops introduced starting in 2010/11); and (ii) it did not operate through private sector retailers or use vouchers; rather, beneficiaries collected their subsidized inputs from their farmers' organization. In contrast, the FISP e-voucher (henceforth, 'e-FISP'): (i) is flexible in that beneficiaries can redeem it for the agricultural inputs or equipment of their choosing, including for any crop, livestock, or fish-farming activity (subject to availability); and (ii) uses e-vouchers redeemable at private retailers' shops – inputs are not distributed in-kind. During the e-FISP pilot years (2015/16 and 2016/17), the e-voucher was a pre-paid Visa card. The e-FISP was piloted in 13 districts in 2015/16 and 39 districts in 2016/17 (the 13 original pilot districts plus 26 additional districts); the traditional

[6] FSP had been in place since the 2002/03 agricultural season. See Mason et al. (2013) for further details on FSP and the ISPs in place in Zambia prior to it.

[7] The agriculture ministry's name has changed frequently over time and is currently MoA.

[8] Agricultural camps are the smallest administrative unit used by the MoA to organize farmers. CACs consist of representatives from the following groups within a given camp: farmers' organizations, traditional leaders, community-based organizations, and public offices other than MoA.

FISP continued to be implemented in the non-pilot districts in these years (see Figure 1). The e-FISP was then implemented nationwide in 2017/18 before being partially rolled back in 2018/19 and 2019/20.[9]

The objectives of the e-FISP include the traditional FISP objectives plus four additional objectives: even greater emphasis on (i) increasing private sector participation and (ii) ensuring timely access to inputs by small-scale farmers; (iii) a goal to improve beneficiary targeting (e.g., by requiring beneficiaries to show their national registration card when collecting and redeeming their e-voucher, and entering a PIN known only by the owner when redeeming); and (iv) promoting agricultural diversification (MAL 2015, 2016). Another difference between the two FISP modalities was the farm size eligibility criterion. For example, in the e-FISP pilot years, the traditional FISP allowable farm size was 0.5-5 ha cultivated. For the e-FISP, it was 0.5-2 ha cultivated and/or that the household raise a certain number of livestock (2-10 cattle, 5-30 pigs, 5-30 goats, 20-100 chickens, or 1-2 fish ponds) (MAL 2015, 2016). This change was in part intended to improve targeting, as previous studies showed that crowding out of commercial demand for fertilizer by subsidized fertilizer was greater among households cultivating more than 2 ha, and that a large share of FISP inputs went to relatively better-off households (Mason & Jayne 2013; Mason et al. 2013). The inclusion of the livestock options for farm size was related to livestock inputs being eligible inputs under the e-FISP.

In this study, we focus on the 2013/14 through 2016/17 agricultural years – years before and during the two-year e-FISP pilot phase.[10] Table 1 summarizes additional information on the traditional and e-FISP programs in these years – namely, the number of intended beneficiaries under each FISP modality, the required farmer contribution per input pack or per e-voucher (K400 all four years), the total value per e-voucher, and the share of FISP in total Zambian government agricultural sector expenditures. Over the four year period of analysis, FISP accounted for an average of 54% of the latter.

[9] The e-FISP was scaled back to cover approximately 60% and 40% of all FISP beneficiaries in 2018/19 and 2019/20, respectively.

[10] An agricultural year in Zambia runs from October 1 through September 30.

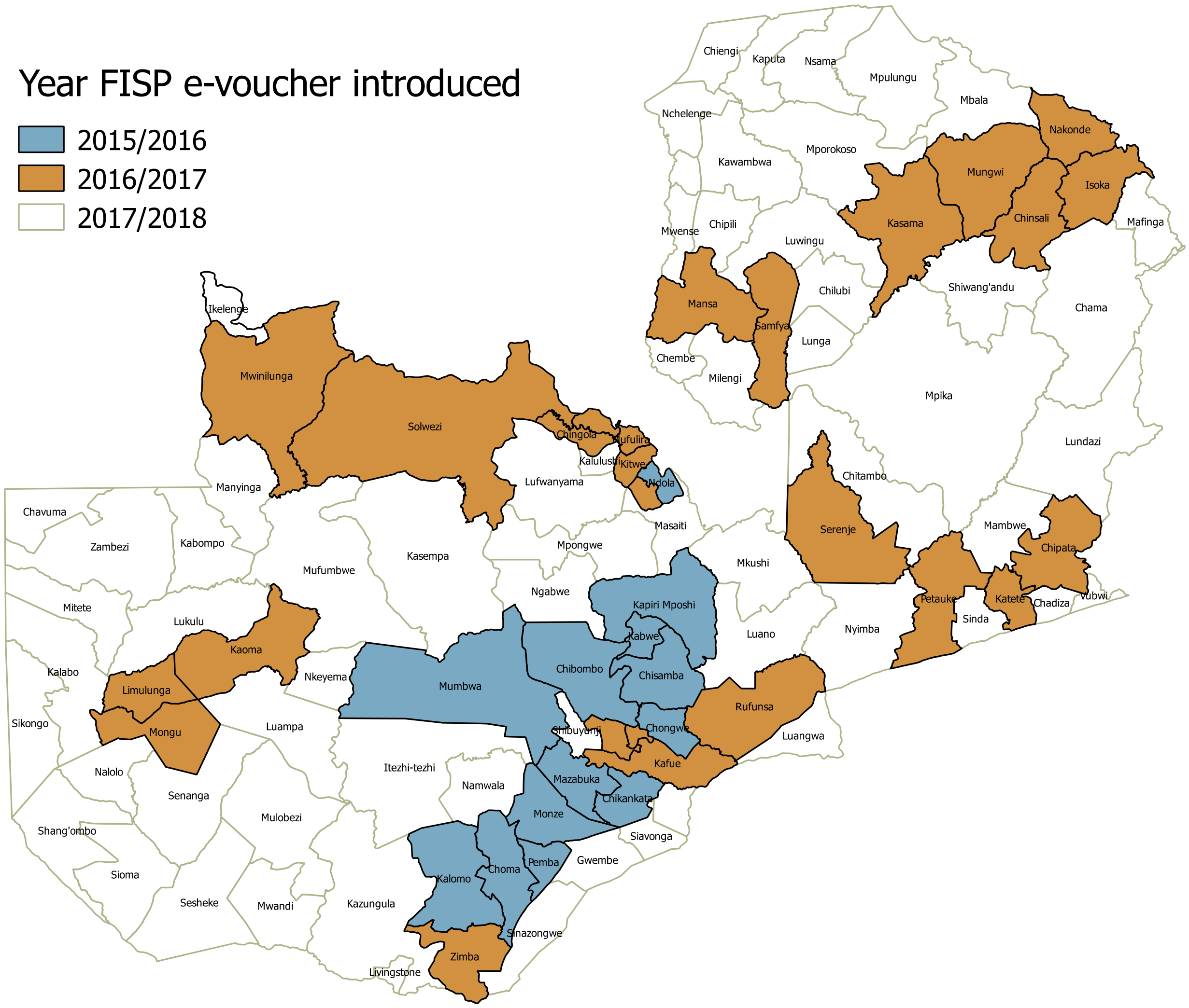


**Figure 1. The rollout of the e-FISP**

**Table 1. Traditional- and e-FISP beneficiaries, farmer contributions, and share of total government agricultural sector expenditures**

| Agricul-tural year | Number of intended beneficiaries: Traditional FISP | Number of intended beneficiaries: e-FISP | Traditional FISP farmer contribution for 200 kg fertilizer + 10 kg maize seed | e-FISP farmer contribution (total e-voucher value in parentheses) | FISP % of total GRZ agricultural sector expenditures | Official exchange rate (K/US$)[b] |
|---|---|---|---|---|---|---|
| 2013/14 | 900,000 | 0 | K400 | N/A | 56% | 5.8 |
| 2014/15 | 1,000,000 | 0 | K400 | N/A | 40% | 7.4 |
| 2015/16 | 759,000 | 241,000 | K400 | K400 (K2,100)[a] | 59% | 9.5 |
| 2016/17 | 1,000,000 | 602,521 | K400 | K400 (K2,100) | 62% | 9.9 |

Notes: K = Zambian Kwacha. GRZ = Government of the Republic of Zambia. [a] The total value in 2015/16 was initially K1,400 but was raised to K2,100 due to an increase in the price of fertilizer (Kuteya et al. 2016). [b] The exchange rate listed is the average across the two calendar years (because the agricultural year starts in October and e-vouchers had to be redeemed by the end of March).
Sources: MAL (various years), Ministry of Finance (various years), World Bank (2019).

In addition to addressing the targeting, crowding out, and maize-centric concerns mentioned above, the e-FISP was intended to address a number of other problems associated with the traditional FISP, namely: (i) diversion and resale of FISP inputs by program implementers; (ii) chronic late delivery of inputs; (iii) failure to support the development of private sector capacity and supply chains for agricultural inputs because the traditional program did not work through private sector retailers; (iv) very high program costs because most program functions were carried out by government; and (v) the same types of fertilizers being provided to all program beneficiaries despite Zambia's diverse agro-ecological conditions[11] (Mason & Jayne 2013; Mason et al. 2013; Kuteya et al. 2016; Resnick & Mason 2016).

[11] Note that under the e-FISP, farmers could use the voucher for any type of fertilizer, not just the compound D and urea that were provided through the traditional FISP.

## 3. DATA

The data are drawn from the 2013/14-2016/17 Zambia Crop Forecast Surveys (CFSs).[12] In the next sub-section, we describe these data. Then, in section 3.2, we describe the outcome variables analyzed.

### 3.1 The CFS

The CFS is a survey implemented annually between March and April by the MoA in conjunction with the Zambia Central Statistical Office (CSO). The CFS data are representative at the national, provincial, and district levels, and cover all districts in the country. The main purpose of the CFS is, as the name suggests, to forecast crop production levels at the upcoming harvest (which typically begins in May and runs through July or August). These figures are then used to calculate Zambia's food balance sheet for key staple crops. At the time CFS data are collected, most maize has reached physiological maturity but has not yet been harvested; many other crops have yet to be harvested as well. Thus, the area planted and input use data collected through the CFS are realized levels but the quantities harvested figures are farmers' estimates of their likely output levels. In this study, we do not use the production forecasts because of concerns about measurement error.

The CFS is conducted in two parts: a survey of smallholder farm households (defined as those cultivating less than 20 ha of land), and a census of larger-scale farms. Given the target population of FISP, we use only the former. Throughout the remainder of the paper, we use the term CFS to refer to only the smallholder portion of the CFS.

The CFS covers all field crops produced by Zambian smallholders. Across the four years of CFS data used here, smallholders reported growing 23 different field crops.[13] The CFS data do not include information on horticultural crop production, livestock production, or fish farming activities, nor on non-land assets or consumption expenditures. However, in addition to the data the CFS captures on field crop production (inputs used, area planted, expected production levels, etc.), the surveys also collect information on the household's total landholding size, the size of each of the household's plots, the respondent's subjective assessment of the soil fertility on each plot, and basic demographic information (e.g., a roster including the gender, age, education, and position in the household (head, spouse, child, etc.) of each household member).

The sampling design for the CFS each year was such that standard enumeration areas (SEAs) were first selected with probability proportionate to size based on the 2010 Census of Population and Housing. Then, all smallholder households in selected SEAs were listed and sorted into one of three categories (A, B, C) based on cultivation of specific crops and the numbers of cattle, goats, pigs, and chickens they were raising.[14] Twenty (20) households were

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[12] We do not use the Rural Agricultural Livelihoods Survey (RALS) data for Zambia here because the years covered in that nationally-representative household panel survey dataset do not include any of the e-FISP pilot years. Rather, all three agricultural seasons covered by the RALS are ones in which FISP was either all traditional (2010/11 and 2013/14) or all e-FISP (2017/18). These data were collected in June-July 2012, 2015, and 2019, respectively.

[13] The 23 crops are: maize, sorghum, rice, millet, sunflowers, groundnuts, soybeans, cotton, Irish potatoes, Virginia tobacco, burley tobacco, mixed beans (common bean), bambara nuts, cowpeas, velvet beans, coffee, sweet potatoes, cassava, cashews, paprika, pineapple, popcorn, and sugarcane.

[14] Category C includes households cultivating 5-19.99 ha; and/or raising 50+ cattle, 20+ pigs, 30+ goats, and/or 50+ chickens; and/or growing one of the following crops if only 1 or 2 households in the SEA grows that crop (rice,

then randomly selected to be interviewed in each SEA as follows: up to 10 from category C, and then equal numbers of category A and B households if a sufficient number of category B households existed in the SEA; if not, additional category A households were selected to bring the total to 20. Table 2 summarizes the total number of SEAs and households interviewed for each of the CFSs analyzed here, as well as the total number of households included in our analytical sample for each year. The latter is slightly less than the total number interviewed due to incomplete information having been collected for some households each year. Note that a new random sample of households is drawn for the CFS each year; thus, the dataset combining the 2013/14-2016/17 CFSs is a pooled cross-sectional dataset of smallholder households, not a household-level panel.

**Table 2. CFS number of SEAs and households**

| CFS year | No. of SEAs | No. of HHs interviewed | No. of HHs in analytical sample (% of total interviewed) |
|---|---|---|---|
| 2013/14 | 677 | 13,428 | 13,284 (98.9%) |
| 2014/15 | 678 | 13,452 | 13,290 (98.8%) |
| 2015/16 | 680 | 13,465 | 13,104 (97.3%) |
| 2016/17 | 680 | 13,525 | 13,236 (97.9%) |
| Total | | 53,870 | 52,914 (98.2%) |

Note: CFS = Crop Forecast Survey. SEA = standard enumeration area. HH = household.

### 3.2 Outcome variables

Table 3 lists the outcome variables analyzed. (See Table A1 in the Appendix for summary statistics for all outcome variables.) We group the outcome variables into several categories, each of which relates to one of more FISP objectives.[15] The access to and use of modern inputs category relates to FISP's goals of improving farmers' access to inputs. We include farmers' use of herbicide as one of the outcome variables (as well as inorganic fertilizer and F1 hybrid maize seed) because herbicide is an input that was not included in the traditional FISP but was something farmers could buy using the e-FISP. Moreover, herbicide use has been increasing over time in Zambia (Grabowski & Jayne 2016). The cropped area and crop diversification category relates to the e-FISP goal of promoting agricultural diversification and reducing the maize-centricity of FISP. The FISP fertilizer accessibility and timeliness category variables are related to the e-FISP's emphasis on further encouraging private sector investment in fertilizer value chains to bring the inputs closer to farmers and on reducing late delivery of FISP inputs.

cotton, sunflower, soybeans, Virginia tobacco, burley tobacco, paprika, pineapple, and cashews). Category B includes households cultivating 2-4.99 ha; and/or growing any of the previously listed crops if 3 to 5 households in the SEA grow that crop. And Category A includes all other farm households that cultivate less than 2 ha (MoA and CSO various years).

[15] We acknowledge that there are additional household-level outcomes that would have been useful to analyze, had they been captured in the CFS – e.g., livestock production, access to/use of livestock vaccines, dip chemicals, and crop protectants other than herbicide, horticultural crop production, etc. However, we are constrained by what is included in the annual CFSs. Other outcomes that would be useful to analyze but that would require data other than household survey data include the savings to the national treasury and the number of new agrodealerships and jobs that may have resulted from the shift to the e-FISP. See Machina et al. (2017) for some descriptive evidence on the latter.

Most of the outcome variables in Table 3 are self-explanatory, thus we focus here on those that require further description. The Simpson index (*SI*) of field crop diversity is calculated for each household in the CFS as follows:

(1) $$SI = 1 - \sum_{c=1}^{23} s_c^2$$

where *c* indexes the field crop and *s* is the share of that crop in a household's total field crops area planted (Joshi et al. 2004). Note that the closer the *SI* value is to one, the greater the level of diversification; an SI value of zero indicates that a household grew only one field crop.

**Table 3. Outcome variables analyzed**

| Category | Outcome variables |
|---|---|
| Access to and use of modern inputs [a] | Km to nearest fertilizer seller (CFS)[b] |
| | =1 if used fertilizer |
| | Maize fertilizer application rate (kg/ha) |
| | =1 if purchased unsubsidized fertilizer |
| | =1 if grew F1 hybrid maize |
| | Hectares of F1 hybrid maize planted |
| | =1 if used herbicide on a field crop |
| Cropped area & crop diversification [c] | Maize share of total area planted |
| | Hectares of maize |
| | Hectares of other field crops |
| | =1 if grew at least one non-maize field crop |
| | Number of field crops grown |
| | Simpson index of field crop diversity |
| FISP accessibility & timeliness | Km to FISP fertilizer collection point [d] |
| | =1 if FISP basal fertilizer available on time [d] |
| | =1 if FISP top dressing fertilizer available on time [d] |

Notes: [a] Fertilizer refers to inorganic/mineral fertilizer throughout this table. [b] Data on km to nearest fertilizer seller not available for the 2016/17 CFS. [c] See Section 3.1 for the list of field crops captured in the CFS. [d] Questions on distance to FISP fertilizer collection point and timeliness of FISP availability on the CFS were asked only of households that acquired fertilizer through FISP; "available on time" in the CFS = 1 if the respondent indicated that the fertilizer was available at the time his/her household needed it.

In the FISP accessibility and timeliness category, due to the way the CFS questionnaire is structured, these variables are only available for FISP fertilizer beneficiaries. Also note that the variable, km to the FISP fertilizer collection point, refers to the location where a farmer picked up the fertilizer from his/her farmers' group for the traditional FISP and to the fertilizer retailer where s/he redeemed the e-voucher for the e-FISP. In each year of the CFS used here, approximately 30% of sample households acquired fertilizer through FISP (Table A1).

## 4. EMPIRICAL STRATEGY

We use a multi-district regression DD model to estimate the short-run effects of the shift from the traditional FISP to the e-FISP using the pooled CFS cross-sectional data. The base model is specified as:

(2) $y_{idt} = \alpha + \delta_{DD} eFISP_{dt} + \boldsymbol{District_d \beta} + \boldsymbol{Year_t \gamma} + \varepsilon_{idt}$

where $y_{idt}$ is the outcome variable for household *i* in district *d* in agricultural year *t* (*t*=2013/14, 2014/15, 2015/16, 2016/17); $eFISP_{dt}$ equals one if the e-FISP was piloted in district *d* in agricultural year *t*; $\boldsymbol{District_d}$ is a vector of district dummies; $\boldsymbol{Year_t}$ is a vector of year dummies (with 2013/14 as the base year); $\varepsilon_{idt}$ is the idiosyncratic error term; $\alpha$, $\delta_{DD}$, $\boldsymbol{\beta}$, and $\boldsymbol{\gamma}$ are parameters to be estimated, with $\delta_{DD}$ being the main parameter of interest – the DD estimate of the shift from the traditional FISP to the e-FISP. Standard errors are clustered at the district level because the policy change is at the district level. The DD specification in Equation (2) is similar to the multistate regression DD model in Angrist and Pischke (2015, p. 194) and is preferable to a simple pre/post, treated/control regression DD model because it allows us to control for a full set of district fixed effects (FE), rather than only controlling for time constant differences between e-FISP pilot and non-pilot districts as aggregate groups.[16] It also allows us to model that the e-FISP was piloted in different districts over time (recall Figure 1). We estimate Equation (2) as specified above and then with Province × Year FE plus two different sets of control variables to test the robustness of the results. The two sets of controls are listed in Table 4 and summary statistics for these variables are provided in Table A2 in the Appendix.

**Table 4. Control variables included in robustness checks**

| Variable | Set #1 | Set #2 [c] |
|---|---|---|
| Province × year FE | X | X |
| Average soil fertility of the HH's fields [a] | X | X |
| Landholding size (ha) | X | X |
| Average plot size (ha) | X | X |
| HH size (no. members) [b] | X | |
| No. of children (under age 15) | | X |
| No. of prime-age adults (age 15-59) | | X |
| No. of older adults (age 60 and up) | | X |
| Age of the HH head (years) | | X |
| =1 if female-headed HH | | X |
| Education of the HH head (years) | | X |
| Maximum education in the HH (years) | | X |

Notes: HH=household. [a] Based on the respondent's subjective assessment of each plot and using the scale: 1=low, 2=medium, and 3=high. The household-level variable is computed as a weighted average using each field's share in the household's total cultivated area as the weights. [b] Household size in Set #1 is equivalent to the sum of the number of children, prime-age adults, and old adults in Set #2. [c] Household head information is missing for 1,416

[16] By simple pre/post, treated/control regression DD model we mean a model of the form: $y_{idt} = \alpha + \beta TREAT_d + \gamma POST_t + \delta_{DD}(TREAT_d \times POST_t) + \varepsilon_{idt}$ where $TREAT_d$ equals one if a district is treated (e.g.., an e-FISP pilot district) and $POST_t$ equals one in years when the e-FISP was piloted.

of 52,914 observations. As a result, models estimated with Set #2 are based on slightly fewer observations than Set #1.

As is widely known, the key assumption needed for $\delta_{DD}$ to be interpreted as a causal effect is the parallel trends assumption – i.e., had the e-FISP *not* been piloted, trends in the outcome variables over time would have been the same in pilot and non-pilot districts. While this cannot be directly tested because we do not observe the counterfactual, we can probe this assumption. We do so in two ways.[17] First, we estimate specifications similar to Equation (2) (with and without the two sets of control variables) but in which we include the lead of the treatment variable and perform a *t*-test on its coefficient, $\lambda$:

(3) $y_{idt} = \alpha + \delta_{DD} eFISP_{dt} + \lambda eFISP_{dt+1} + \boldsymbol{District_d \beta} + \boldsymbol{Year_t \gamma} + \varepsilon_{idt}$

This tests for the presence of 'pre-treatment treatment effects', which should not exist if the policy change is an exogenous shock (i.e., we should fail to reject the null hypothesis that $\lambda$=0) . This approach is recommended in Angrist and Pischke (2009), who cite the application by Autor (2003). The test is in the vein of a Granger causality test (Granger 1969). We fail to reject the null hypothesis at the 10% level or lower in 45 of 48 cases (Tables A3-A5 in the Appendix).[18] Thus, the weight of the evidence is consistent with there being no pre-treatment treatment effects, and lends support to the parallel trends assumption.

The second way we probe the key DD assumption is by examining graphs of the mean values of the various outcome variables in the CFS years *prior* to the introduction of the e-FISP in pilot versus non-pilot districts to visually check for parallel trends prior to the policy change. For 2015/16 e-FISP pilot districts, we compare the trend in the mean of a given outcome variable between 2013/14 and 2014/15 to that in non-pilot districts; and for 2016/17 e-FISP pilot districts, we compare the trends from 2013/14 to 2014/15 and 2014/15 to 2015/16 to those in the non-pilot districts. See Figures A1-A16 in the Appendix for the associated figures. For almost all of the 16 outcome variables considered, the trends prior to the introduction of the e-FISP are very similar between non-pilot districts and 2016/17 pilot districts. The main exceptions are the mean hectares planted to other crops (Figure A9), and between 2014/15 and 2015/16 for the percentage of recipients getting FISP top dressing on time (Figure A16). In contrast, for 2015/16 pilot districts, the trends in average values prior to the pilot differ substantially from those in the non-pilot districts for more than half (nine of the 16) of the outcome variables: distance to the nearest fertilizer seller (Figure A1), maize fertilizer application rate (Figure A4), percentage of households using herbicide (Figure A6), percentage of households growing a non-maize crop (Figure A11), number of crops grown (Figure A12), Simpson index of crop diversification (Figure A13), and all three FISP fertilizer accessibility/timeliness variables (Figures A14-A16). The differences in trends prior to the policy change especially between 2015/16 pilot districts and non-pilot districts could be related to the reasons why the initial 13 districts were chosen as the initial pilot districts: better accessibility

[17] If we had more years of data, we could consider allowing district-specific trends (Angrist & Pischke 2015), but this is inadvisable with only four years of data as we have here. The CFS was based on a different sampling frame in earlier years, so it is not possible to include more pre-e-FISP years in the analysis.

[18] Forty eight cases = 16 outcome variables times three model specifications (no controls, Set #1 controls, and Set #2 controls). The three cases in which we reject $\lambda$=0 are: (1) distance to the nearest fertilizer seller ($p<0.10$), (2) hectares of F1 hybrid maize ($p<0.10$), and hectares of maize ($p<0.05$) – but in only one of three specifications each (namely, the specification with Set #2 controls).

(they are generally along the line of rail, which also has better road infrastructure) and better mobile phone coverage (to support the e-voucher platform/Visa point-of-sale machines that were used when farmers redeemed their e-FISP card).[19]

Overall, the results of including the lead of the e-FISP variable are consistent with the parallel trends assumption but we have concerns about non-parallel trends prior to the introduction of the e-voucher for several outcome variables for 2015/16 pilot districts vis-à-vis non-pilot districts (but less so for 2016/17 pilot districts vis-à-vis non-pilot districts). We therefore report two sets of DD estimates – one including and one excluding the 2015/16 pilot districts.

[19] We explored instrumenting for being an e-FISP pilot district using a dummy variable equal to one if the colonial-era line of rail passes through the district, and equal to zero otherwise. Unfortunately, this variable is not sufficiently strong to be used as an instrument (the partial F-statistic is, at most, 8.4, p=0.007). In addition, because this variable only varies at the district level and not over time, it is perfectly collinear with the district dummies; hence, province dummies (instead of district ones) had to be used in the first stage regression. Another robustness check we explored was using placebo outcome variables; however, given the nature of the CFS data and its focus on crop production, which could be affected by the e-FISP pilot, we were unable to identify any variables in the data to use as placebo outcomes.

## 5. RESULTS AND DISCUSSION

### 5.1 Results

In the main text, we report results based on Equation (2) that exclude 2015/16 pilot districts (see Tables 5-7). Then, in the Appendix (Tables A6-A8), we report analogous results that include 2015/16 pilot districts. With only one exception, when a $\delta_{DD}$ estimate is statistically different from zero in the results excluding 2015/16 pilot districts, it is also statistically significant at the 10% level or lower and of the same sign in the results including 2015/16 pilot districts.[20] Looking across outcome variables and generally speaking, the estimates of $\delta_{DD}$ are much more precisely measured (and in many cases, larger in magnitude) when we exclude the 2015/16 pilot districts. These results are also robust to the inclusion of different control variables. We focus our discussion of the results mainly on those excluding 2015/16 pilot districts, but make note of substantive differences as they arise. Readers are reminded that what we capture here are short-run effects, and that the effects might be different in the longer run.

Contrary to the e-FISP goal of further improving farmers' access to inputs, the results in Table 5 suggest that the shift to the e-FISP either had no statistically significant effect on or negatively affected input use.[21] More specifically, on average and other factors constant, the shift from the traditional- to the e-FISP had no statistically significant effect on smallholder households' purchases of fertilizer at unsubsidized prices or their use of herbicide on field crops. The shift negatively affected fertilizer and F1 hybrid maize seed use, resulting in 6-7 percentage point decreases in the likelihood that a household used fertilizer, and 9-10 percentage point decreases in the likelihood that it used F1 hybrid maize seed. The extent of use of these inputs also declined as a result of the shift to the e-FISP: by 36-40 kg/ha for the maize fertilizer application rate, and by 0.1 hectares for area planted with F1 hybrid maize seed. Using the low end of each of these ranges and comparing the magnitudes to the sample mean for each variable in Table A1, these changes are equivalent to declines of approximately 11% and 18% for the use of fertilizer and hybrid maize seed, respectively, 19% for the maize fertilizer application rate, and 16% for the area of F1 hybrid maize.

The weight of the evidence also suggests that the e-FISP pilot program did not achieve its crop diversification goal (at least for field crops). Per the results in Table 6, relative to the traditional FISP, the e-FISP had no statistically significant effect on any of the cropped area or crop diversification outcome variables considered, and all of the point estimates are very close to zero. These results exclude the 2015/16 pilot districts. When we include those districts, we find very weak evidence of some crop diversification away from maize (namely, declines in the hectares and share of area under maize, and increases in the hectares under and number of non-

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[20] The exception is for the binary variable for if a household purchased unsubsidized fertilizer and including Set #1 controls. The estimate of $\delta_{DD}$ is statistically significant at the 1% level in the results excluding the 2015/16 pilot districts, but not statistically different from zero at the 10% level when those districts are included. (Compare Table 5 to Table A6 for this outcome variable, Set #1 controls column.)

[21] The same is true when we include the 2015/16 pilot districts – see Table A6 in the Appendix. The main differences to note there (but interpreting these results with caution due to concerns about the parallel trends assumption being violated) are, first, that we find no statistically significant effect on the distance to the nearest fertilizer seller. This outcome variable is not available for the 2016/17 CFS, so could not be analyzed for the sample excluding 2015/16 pilot districts. The second difference is that in Table A6 we find some evidence of negative effects on the likelihood that a household purchased unsubsidized fertilizer, whereas these effects are not statistically different from zero in the sample excluding 2015/16 pilot districts (Table 5).

maize crops, as well as in the Simpson index of crop diversification); however, several of these results are only statistically significant at the 10% level and all of the estimates cease to be statistically different from zero once we add controls (Table A7).

Finally, we examine the effects of the shift to the e-FISP on the distance households had to travel to acquire fertilizer through FISP and whether or not that fertilizer was available at the time the households needed it (henceforth, "on time"). Here again, we find no evidence that the e-voucher approach to FISP fared better than the traditional FISP. Rather, the shift to the e-FISP is associated with a 7.5-8.2 km *increase* in the distance farmers had to travel to collect fertilizer through the program, and a 23-28 percentage point (21-26 percentage point) *decline* in the share of FISP basal (top dressing) fertilizer recipients reporting having received the inputs on time (Table 7). (We discuss this further below.) Relative to the sample means in Table A1, this is more than a doubling of the distance to the FISP fertilizer collection point, and a greater than 30% decline in the likelihood of receiving FISP fertilizer on time. The results are very similar (though smaller in magnitude) when we include 2015/16 pilot districts (Table A8 in the Appendix). Recall that these outcome variables could only be computed for households that actually acquired fertilizer through FISP. They are thus likely lower bounds (in terms of the absolute value of the effects). That is, long distances and late delivery may have resulted in many households acquiring no fertilizer through FISP; had we been able to include such households in the analysis, the negative effects as a result of the shift to the e-voucher may have been even greater.

**Table 5. Estimated effects of the shift to the e-FISP in 2016/17 on smallholder households' purchase and use of modern inputs (excluding 2015/16 e-FISP pilot districts)**

| Explanatory variables: | =1 if purchased unsubsidized fertilizer | | | =1 if used fertilizer | | | Maize fertilizer application rate (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | 0.007 | 0.001 | -0.001 | -0.060*** | -0.071*** | -0.072*** | -35.55*** | -39.66*** | -39.14*** |
| | (0.021) | (0.019) | (0.019) | (0.020) | (0.017) | (0.017) | (7.32) | (6.49) | (6.63) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 43,484 | 43,478 | 42,079 | 43,484 | 43,478 | 42,079 | 38,450 | 38,444 | 37,177 |
| R-squared | 0.131 | 0.155 | 0.169 | 0.245 | 0.276 | 0.295 | 0.278 | 0.288 | 0.302 |

| Explanatory variables: | =1 if grew F1 hybrid maize | | | Hectares of F1 hybrid maize | | | =1 if used herbicide on a field crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | -0.094*** | -0.094*** | -0.098*** | -0.10** | -0.11*** | -0.11*** | -0.002 | -0.002 | -0.002 |
| | (0.031) | (0.024) | (0.024) | (0.04) | (0.03) | (0.03) | (0.009) | (0.006) | (0.006) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 43,484 | 43,478 | 42,079 | 43,484 | 43,478 | 42,079 | 43,484 | 43,478 | 42,079 |
| R-squared | 0.169 | 0.205 | 0.230 | 0.083 | 0.427 | 0.440 | 0.069 | 0.087 | 0.092 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls. The maize fertilizer application models are estimated for maize-growing households only.
Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table 6. Estimated effects of the shift to the e-FISP in 2016/17 on smallholder households' field cropped area and field crop diversification (excluding 2015/16 e-FISP pilot districts)**

| Explanatory variables: | Hectares of maize | | | Hectares of non-maize field crops | | | Maize share of total field crops area planted | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | -0.01 | 0.00 | -0.00 | 0.04 | 0.00 | -0.01 | -0.003 | -0.000 | 0.002 |
| | (0.05) | (0.02) | (0.02) | (0.05) | (0.03) | (0.03) | (0.012) | (0.009) | (0.011) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 43,484 | 43,478 | 42,079 | 43,484 | 43,478 | 42,079 | 43,429 | 43,423 | 42,032 |
| R-squared | 0.153 | 0.630 | 0.637 | 0.128 | 0.304 | 0.308 | 0.359 | 0.373 | 0.398 |

| Explanatory variables: | =1 if grew at least one non-maize field crop | | | Number of field crops grown | | | Simpson index of field crop diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | -0.010 | -0.002 | -0.006 | 0.00 | -0.02 | -0.02 | -0.006 | -0.007 | -0.008 |
| | (0.017) | (0.013) | (0.015) | (0.07) | (0.05) | (0.06) | (0.012) | (0.008) | (0.008) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 43,484 | 43,478 | 42,079 | 43,484 | 43,478 | 42,079 | 43,429 | 43,423 | 42,032 |
| R-squared | 0.172 | 0.195 | 0.206 | 0.202 | 0.275 | 0.280 | 0.223 | 0.265 | 0.273 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.
Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table 7. Estimated effects of the shift to the e-FISP in 2016/17 on smallholder households' distance to and timeliness of FISP fertilizer – among recipients only (excluding 2015/16 e-FISP pilot districts)**

| **Explanatory variables:** | **Km to the HH's FISP fertilizer collection point** | | | **=1 if FISP basal dressing was available on time** | | | **=1 if FISP top dressing was available on time** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | 7.46*** | 8.14*** | 8.18*** | -0.233*** | -0.279*** | -0.278*** | -0.213** | -0.264*** | -0.264*** |
| | (1.60) | (1.46) | (1.48) | (0.076) | (0.064) | (0.063) | (0.084) | (0.082) | (0.080) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 14,762 | 14,758 | 14,625 | 14,854 | 14,850 | 14,717 | 14,946 | 14,942 | 14,809 |
| R-squared | 0.036 | 0.045 | 0.047 | 0.130 | 0.171 | 0.173 | 0.123 | 0.174 | 0.177 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.

Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

## 5.2 Discussion

The piloting of the e-voucher approach to FISP was a well-intended policy change, and it was hoped that this innovation in program design would improve farmers' access to and use of modern inputs; incentivize private sector investment in fertilizer and other input value chains, thereby improving the timely availability of the inputs and bringing them closer to farmers; and encourage farmers to diversify away from maize by allowing them to use the e-voucher for the farm inputs or equipment of their choosing – not just maize seed and fertilizer. Our results suggest that these goals were not achieved, at least in the short-run and based on the outcome variables that could be analyzed using the CFS data. At best, outcomes were no different (in a statistically significant way) under the e-FISP relative to the traditional FISP; at worst, outcomes were worse under the e-FISP. So what happened? Independent monitoring and evaluation reports of the e-FISP by the Indaba Agricultural Policy Research Institute (IAPRI), based in Lusaka, point to several hiccups in the piloting of the e-FISP that likely explain these results.

First, there were substantial delays in both pilot years in getting e-FISP Visa cards (henceforth "e-cards") into farmers' hands and/or getting the e-cards activated in a timely manner. More specifically, in 2015/16, delayed submission of e-FISP beneficiary lists to the main MoA FISP Programme Coordination Office by some District Agricultural Coordinators (DACOs, to whom the Camp Agricultural Committees submit the approved beneficiary lists) delayed the production and distribution of e-cards to beneficiaries (Kuteya et al. 2016). Kuteya et al. attribute the delayed submission of beneficiary lists to the lack of equipment at the district level for the DACOs to scan and email the necessary forms – a problem that was exacerbated by frequent power cuts. The authors also indicate that there may have been deliberate efforts by some civil servants to derail the e-FISP because they materially benefited under the traditional FISP – e.g., by diverting the physical inputs for their own use or to sell on the market. (See Mason and Jayne (2013) and Mason et al. (2013) for more on diversion.) Delays continued in 2016/17, this time due to delays in the release of government funds for the e-FISP, resulting in late distribution of e-cards (Kuteya & Chapoto 2017). By the time many farmers received their e-cards in late December 2016, they had already planted their maize, so some maize inputs acquired through FISP were likely held until the next agricultural season. Other challenges included e-card activation taking three or more weeks after farmers made their K400 contributions; issues with e-card PINs, or names being misspelled and not matching beneficiaries' national registration cards; and other unexplained e-card failures (e.g., cards that were activated but did not work when swiped at a retailer's point of sale machine) (Kuteya et al. 2016; Kuteya & Chapoto 2017). The authors argue that in both pilot years, retailers had inputs stocked on time and ready for farmers to purchase with their e-cards, such that the bottlenecks were on the demand side, not the supply side (Ibid.). The various challenges outlined here likely explain the negative effects of the shift to the e-voucher on the timely availability of fertilizer through FISP in Table 7, and the negative or null effects on fertilizer, hybrid maize seed, and herbicide use in Table 5. An additional challenge that likely contributed to the negative effects on fertilizer use and the maize fertilizer application rate was rising fertilizer prices over the course of the season, especially in the 2015/16 pilot year (Kuteya et al. 2016). This would have disproportionately affected e-FISP beneficiaries, as the inputs they purchased would have been at the market price, with the value of the e-voucher defraying their out of pocket costs. In contrast, traditional FISP beneficiaries were to receive four 50-kg bags of fertilizer and 10 kg of maize seed for their K400 farmer contribution, regardless of the market prices. The Zambian government raised the total value of the e-voucher in 2015/16 to try to offset the fertilizer price rise, but it may have been insufficient (Ibid.).

Second, there were issues with e-FISP beneficiaries either not being aware that the e-voucher could be used on things other than fertilizer and maize seed, and some cooperative/farmers' group chairpersons arranging for fertilizer and maize seed to be delivered by agrodealers to farmers (Kuteya et al. 2016; Kuteya & Chapoto 2017). Although the latter may have reduced the distance some e-FISP beneficiaries had to travel to redeem their e-cards, it also denied them the opportunity to purchase other farm inputs or equipment if maize inputs were not what they would have purchased had they been given a choice. Both of these issues, coupled with late distribution and activation of e-cards, likely explain the lack of effects of the shift to the e-FISP on herbicide use and crop diversification in Tables 5 and 6.[22] Another contributing factor may have been lack of inputs other than maize seed and fertilizer at some agrodealers' shops (Kuteya et al. 2017; Siame et al. 2017). Particularly if input suppliers were not convinced that government would continue to implement the e-FISP in future years, and/or they were uncertain of the effective demand for such inputs, they may not have had the confidence they needed to invest to build up the requisite supply chains.

Third, the finding in Table 7 that the e-FISP pilot resulted in FISP fertilizer beneficiaries having to travel farther to collect their fertilizer relative to the traditional FISP is almost certainly due to the fact that e-FISP beneficiaries had to travel to a private fertilizer retailer/agrodealer to source the fertilizer (unless special arrangements were made – e.g., by their cooperative chairperson), whereas traditional FISP beneficiaries collected the fertilizer from their cooperative/farmers' group. Although it was hoped that the e-FISP would encourage more private sector agrodealerships to be set up, thereby improving farmers' access to inputs (via FISP and in general), it is unlikely that this happened right away. Most farmers do not have an agrodealership right in their community; instead, these are often located in district towns, at considerable distance from many smallholders' homesteads.

The CFS data do not include information on all respondents' distances to the nearest private fertilizer seller, agrodealer, or FISP collection point, but the Rural Agricultural Livelihoods Survey data collected by IAPRI, MoA, and CSO do. Table 8 shows summary statistics on these distances as of June-July 2015 (prior to the e-FISP pilot) and June-July 2019 (after the e-FISP had been rolled out nationwide and subsequently scaled back to approximately 60% of the beneficiaries). As shown in Table 8, prior to the e-FISP, the median distance to the nearest FISP collection point was 2-5 km, with some variation by (future) e-FISP pilot status, whereas the median distance to the nearest private fertilizer seller (agrodealer) was 25 km (20-21 km).[23] By 2019, the median distance to the nearest FISP collection point was 5-6 km (because roughly 60% of FISP beneficiaries were under the e-FISP at that time). The median distance to the nearest fertilizer retailer (agrodealer) was lower in 2019 than in 2015 but especially so in areas where the e-FISP had been piloted. While we cannot attribute this reduction to the e-FISP, these data are

[22] Surveys from IAPRI in 10 districts where the e-FISP was introduced in 2015/16 suggest that 61% of e-FISP transactions in 2015/16 were for fertilizer, 24% were for hybrid maize seed, and the remaining 15% was mainly for veterinary drugs/dip chemicals, herbicides/insecticides, and horticultural inputs. A similar pattern held in 2016/17 but with even more transactions for fertilizer (67%) and slightly less for hybrid maize seed (20%) and other inputs (13%). The three 2015/16 e-FISP pilot districts not covered in these surveys were Ndola, Kalomo, and Mumbwa.

[23] Not all agrodealers sell fertilizer, hence this distinction. For some households, the nearest private fertilizer seller is the nearest agrodealer, or the two establishments are located near each other.

consistent with what we would expect to see if, with a few years' lag, the e-FISP did incentivize more input retail outlets to be set up. This is also consistent with descriptive (not causal) estimates by Kuteya and Chapoto (2017) that approximately 230 new agrodealerships were set up in response to the 2015/16 e-FISP pilot, and that this rose to 422 in 2016/17.[24]

Finally, two other factors likely further discouraged private input supplier participation in the e-FISP and/or their investment in their retail networks. First, there were issues with the retailers' portion of the e-voucher value not being automatically remitted to their account when the e-card was swiped at their point of sale machine (Kuteya et al. 2017; Kuteya and Chapoto 2018). And second, even once e-FISP pilot districts were announced prior to the 2015/16 and 2016/17 agricultural seasons, respectively, there was major uncertainty as to if and where the e-FISP would actually be implemented.

**Table 8. Distances to the nearest private fertilizer seller, agrodealer, and FISP collection point, June-July 2015 and 2019**

| | 2015 (N=7,933) | | | | 2019 (N=7,241) | | | |
|---|---|---|---|---|---|---|---|---|
| | | Percentiles | | | | Percentiles | | |
| **Districts** | **Mean** | **25th** | **50th** | **75th** | **Mean** | **25th** | **50th** | **75th** |
| All districts | | | | | | | | |
| Private fertilizer seller | 35.2 | 10 | 25 | 50 | 32.0 | 7 | 20 | 45 |
| Agrodealer | 32.5 | 8 | 20 | 45 | 29.5 | 5 | 16 | 40 |
| FISP collection point | 7.7 | 1 | 3 | 7 | 16.4 | 2 | 5 | 20 |
| 2015/16 e-FISP pilot districts | | | | | | | | |
| Private fertilizer seller | 30.6 | 8 | 25 | 45 | 25.9 | 6 | 18 | 40 |
| Agrodealer | 27.4 | 8 | 20 | 40 | 22.5 | 5 | 13 | 30 |
| FISP collection point | 7.8 | 2 | 5 | 8 | 16.1 | 3 | 6 | 20 |
| 2016/17 e-FISP pilot districts | | | | | | | | |
| Private fertilizer seller | 36.7 | 10 | 25 | 50 | 29.6 | 6 | 20 | 40 |
| Agrodealer | 33.6 | 8 | 20 | 45 | 26.2 | 5 | 15 | 35 |
| FISP collection point | 6.5 | 0 | 2 | 6 | 14.8 | 1 | 5 | 15 |
| Non-pilot districts | | | | | | | | |
| Private fertilizer seller | 36.0 | 10 | 25 | 54 | 36.1 | 8 | 22 | 50 |
| Agrodealer | 34.0 | 8 | 21 | 50 | 34.5 | 7 | 20 | 45 |
| FISP collection point | 8.5 | 1 | 3 | 8 | 17.6 | 2 | 5 | 20 |

Source: IAPRI/CSO/MoA Rural Agricultural Livelihoods Surveys, 2015 and 2019.

[24] Machina et al. (2017), based on interviews with 13 agrodealers in districts where the e-FISP was implemented in 2015/16 and 2016/17, estimate that approximately 1,700 agrodealer-related jobs were created due to the e-FISP.

## 6. CONCLUSIONS AND POLICY IMPLICATIONS

This study adds to the thin evidence base on how 'market-smart' reforms to ISPs affect program outcomes, using Zambia's shift from the traditional FISP to the e-FISP as a case study. The e-FISP was intended to be smarter than the traditional FISP: (i) by involving the private sector to a much greater extent; (ii) by putting farmers in control of what inputs or equipment they acquired through the program; (iii) by targeting households with smaller farm sizes; and (iv) through additional efforts to prevent non-farmers and ineligible farmers from participating in the program. The results suggest that, at least in the short run and relative to the traditional FISP, the e-FISP pilot program had no statistically significant effect on the likelihood that a smallholder farm household purchased unsubsidized fertilizer or used herbicide, nor on cropping patterns and crop diversification. In addition, the shift was associated with reductions in the use of fertilizer and F1 hybrid maize seed, as well as in the maize fertilizer application rate. And among households acquiring fertilizer through FISP, it was more likely to be late and collected from farther away under the e-FISP relative to the traditional program.

In the previous section, we discussed several of the likely reasons for these disappointing results. Most of these issues point to implementation challenges as opposed to fundamental flaws in the design of the program. For the e-FISP to realize its potential and achieve its goals of increasing private sector participation in agro-input value chains as well as improving farmers' access to inputs and the timeliness thereof, it will require an earlier mobilization of funds for the program, and an earlier start to program activities. Moreover, the rollback of the e-FISP in recent years coupled with a lack of clear signals about where it will be implemented in future years is likely undermining the potential of the e-FISP by creating even more uncertainty and fewer incentives for private sector players to invest in retail networks or to stock more diverse inputs. Greater sensitization of beneficiaries on the flexibility of the e-FISP may also be needed. Much of this comes down to questions of resource availability, political will, and there being policy champions that can advocate for the e-FISP at high levels of the Zambian government (Resnick & Mason 2016; Resnick et al. 2018).

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## APPENDIX

**Table A1. Summary statistics for FISP fertilizer acquisition, outcome variables, and the share of sample households located in FISP e-voucher pilot districts (pooled observations for 2013/14 - 2016/17)**

| Variable | N | Mean | Std. dev. |
|---|---|---|---|
| ***FISP fertilizer acquisition*** | | | |
| =1 if acquired any fertilizer through FISP | 52,914 | 0.299 | 0.458 |
| =1 if HH acquired basal dressing through FISP | 52,914 | 0.294 | 0.456 |
| =1 if HH acquired top dressing through FISP | 52,914 | 0.296 | 0.457 |
| | | | |
| ***Outcome variables*** | | | |
| <u>Access to/use of modern inputs</u> | | | |
| Km to the nearest fertilizer seller [a] | 39,678 | 39.3 | 43.3 |
| =1 if purchased unsubsidized fertilizer | 52,914 | 0.283 | 0.450 |
| =1 if used fertilizer | 52,914 | 0.561 | 0.496 |
| Maize fertilizer application rate (kg/ha) – maize growers only | 47,628 | 185 | 192 |
| =1 if grew F1 hybrid maize | 52,914 | 0.510 | 0.500 |
| Hectares of F1 hybrid maize | 52,914 | 0.64 | 1.23 |
| =1 if used herbicide on a field crop | 52,914 | 0.071 | 0.257 |
| | | | |
| <u>Cropped area & crop diversification</u> | | | |
| Hectares of maize | 52,914 | 0.96 | 1.28 |
| Hectares of non-maize field crops | 52,914 | 0.75 | 0.93 |
| Maize share of total area planted | 52,787 | 0.554 | 0.325 |
| =1 if grew at least one non-maize field crop | 52,914 | 0.815 | 0.389 |
| Number of field crops grown | 52,914 | 2.46 | 1.23 |
| Simpson index of field crop diversity | 52,787 | 0.378 | 0.255 |
| | | | |
| <u>Distance to & timeliness of FISP fertilizer (recipients only)</u> | | | |
| Km to the HH's FISP fertilizer collection point | 17,842 | 7.4 | 20.7 |
| =1 if FISP basal dressing was available on time | 17,886 | 0.694 | 0.461 |
| =1 if FISP top dressing was available on time | 17,999 | 0.655 | 0.475 |
| | | | |
| ***Share of HHs in e-FISP pilot districts*** | | | |
| =1 if in an e-FISP pilot district in 2015/16 (2015/16 obs. only) | 13,104 | 0.184 | 0.387 |
| =1 if in an e-FISP pilot district in 2016/17 (2016/17 obs. only) | 13,236 | 0.516 | 0.500 |

Note: [a] Not available for 2016/17.

Sources: 2013/14, 2014/15, 2015/16, and 2016/17 CSO/MoA Crop Forecast Surveys.

**Table A2. Summary statistics for control (and related) variables (pooled observations for 2013/14 – 2016/17)**

| Variable | N [a] | Mean | Std. dev. |
|---|---|---|---|
| Household size (no. members) | 52,914 | 6.2 | 3.5 |
| No. of children (under age 15) | 52,914 | 2.8 | 2.3 |
| No. of prime-age adults (age 15-59) | 52,914 | 3.0 | 2.1 |
| No. of older adults (age 60 and up) | 52,914 | 0.4 | 0.8 |
| Age of the HH head (years) | 51,523 | 44.8 | 15.1 |
| =1 if female-headed HH | 51,584 | 0.227 | 0.419 |
| Education of the HH head (years) | 51,554 | 6.2 | 3.8 |
| Max. education in the HH (years) | 51,584 | 7.9 | 3.3 |
| Average soil fertility of the HH's fields (1=low, 2=medium, 3=high) | 52,906 | 1.97 | 0.58 |
| Landholding size (ha, all fields excluding rented-in and borrowed-in fields) | 52,914 | 3.37 | 6.29 |
| Average plot size (ha) | 52,914 | 0.65 | 0.64 |
| =1 if 2013/14 agricultural year | 52,914 | 0.244 | 0.429 |
| =1 if 2014/15 agricultural year | 52,914 | 0.249 | 0.432 |
| =1 if 2015/16 agricultural year | 52,914 | 0.250 | 0.433 |
| =1 if 2016/17 agricultural year | 52,914 | 0.258 | 0.437 |

Note: [a] Data missing for some households if N is less than 52,914.
Sources: 2013/14, 2014/15, 2015/16, and 2016/17 CSO/MoA Crop Forecast Surveys

**Table A3. Tests for pre-treatment treatment effects in smallholder households' access to and use of modern inputs**

| Explanatory variables: | Km to the nearest fertilizer seller [a] | | | =1 if purchased unsubsidized fertilizer | | | =1 if used fertilizer | | | Maize fertilizer application rate (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | -1.90 | 2.38 | 3.02 | -0.044** | -0.033* | -0.032* | -0.034** | -0.037* | -0.037** | -13.73* | -20.07** | -19.19** |
| | (3.62) | (6.30) | (6.19) | (0.019) | (0.017) | (0.017) | (0.016) | (0.019) | (0.018) | (7.10) | (7.90) | (7.78) |
| $eFISP_{dt+1}$ | -3.26 | -2.97 | -6.13* | -0.025 | -0.022 | -0.016 | 0.005 | 0.001 | 0.004 | -4.79 | -6.31 | -6.66 |
| | (2.80) | (3.55) | (3.41) | (0.023) | (0.017) | (0.018) | (0.022) | (0.015) | (0.016) | (6.82) | (6.34) | (6.74) |
| District FE | X | X | X | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X | | | X |
| Observations | 39,678 | 39,671 | 38,259 | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 47,628 | 47,620 | 46,336 |
| R-squared | 0.173 | 0.179 | 0.191 | 0.148 | 0.171 | 0.185 | 0.242 | 0.272 | 0.288 | 0.246 | 0.256 | 0.272 |

| Explanatory variables: | =1 if grew F1 hybrid maize | | | Hectares of F1 hybrid maize | | | =1 if used herbicide on a field crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | -0.088*** | -0.074*** | -0.075*** | -0.15*** | -0.08** | -0.08** | -0.001 | 0.003 | 0.003 |
| | (0.022) | (0.023) | (0.022) | (0.03) | (0.03) | (0.03) | (0.008) | (0.007) | (0.007) |
| $eFISP_{dt+1}$ | 0.006 | 0.015 | 0.024 | 0.03 | 0.04 | 0.05* | 0.006 | 0.010 | 0.011 |
| | (0.016) | (0.017) | (0.017) | (0.03) | (0.03) | (0.03) | (0.010) | (0.008) | (0.008) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 |
| R-squared | 0.183 | 0.218 | 0.240 | 0.120 | 0.477 | 0.486 | 0.066 | 0.088 | 0.094 |

Note: [a] Data not available for 2016/17. *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls. The maize fertilizer application models are estimated for maize-growing households only.
Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table A4. Tests for pre-treatment treatment effects in smallholder households' field cropped area and field crop diversification**

| Explanatory variables: | Hectares of maize | | | Hectares of non-maize field crops | | | Maize share of total field crops area planted | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | -0.06** | -0.00 | -0.00 | 0.09** | 0.01 | 0.01 | -0.025* | 0.002 | 0.003 |
| | (0.03) | (0.03) | (0.03) | (0.04) | (0.03) | (0.03) | (0.013) | (0.009) | (0.009) |
| $eFISP_{dt+1}$ | 0.01 | 0.03 | 0.04** | -0.04 | -0.05 | -0.04 | 0.006 | 0.013 | 0.012 |
| | (0.03) | (0.02) | (0.02) | (0.04) | (0.03) | (0.03) | (0.013) | (0.012) | (0.007) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,787 | 52,779 | 51,371 |
| R-squared | 0.159 | 0.630 | 0.635 | 0.112 | 0.288 | 0.291 | 0.366 | 0.380 | 0.399 |

| Explanatory variables: | =1 if grew at least one non-maize field crop | | | Number of field crops grown | | | Simpson index of field crop diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | 0.015 | -0.005 | -0.008 | 0.12* | -0.00 | -0.01 | 0.022* | 0.004 | 0.003 |
| | (0.019) | (0.015) | (0.015) | (0.07) | (0.05) | (0.05) | (0.012) | (0.008) | (0.008) |
| $eFISP_{dt+1}$ | 0.018 | 0.009 | 0.017 | 0.02 | -0.00 | 0.01 | 0.004 | 0.003 | 0.004 |
| | (0.016) | (0.014) | (0.011) | (0.05) | (0.04) | (0.05) | (0.009) | (0.008) | (0.008) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,787 | 52,779 | 51,371 |
| R-squared | 0.156 | 0.183 | 0.191 | 0.186 | 0.263 | 0.268 | 0.212 | 0.256 | 0.263 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.

Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table A5. Tests for pre-treatment treatment effects in smallholder households' distance to and timeliness of FISP fertilizer – among recipients only**

| Explanatory variables: | Km to the HH's FISP fertilizer collection point | | | =1 if FISP basal dressing was available on time | | | =1 if FISP top dressing was available on time | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | 7.49*** | 6.39*** | 6.44*** | -0.162*** | -0.204*** | -0.203*** | -0.138** | -0.194*** | -0.193*** |
| | (1.31) | (1.30) | (1.31) | (0.055) | (0.054) | (0.054) | (0.059) | (0.068) | (0.067) |
| $eFISP_{dt+1}$ | -1.00 | -0.04 | 0.04 | 0.051 | -0.027 | -0.025 | 0.037 | -0.028 | -0.027 |
| | (1.09) | (1.06) | (1.07) | (0.036) | (0.035) | (0.036) | (0.042) | (0.052) | (0.053) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 17,842 | 17,837 | 17,701 | 17,886 | 17,881 | 17,745 | 17,999 | 17,994 | 17,858 |
| R-squared | 0.053 | 0.063 | 0.064 | 0.126 | 0.163 | 0.165 | 0.115 | 0.161 | 0.164 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.
Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

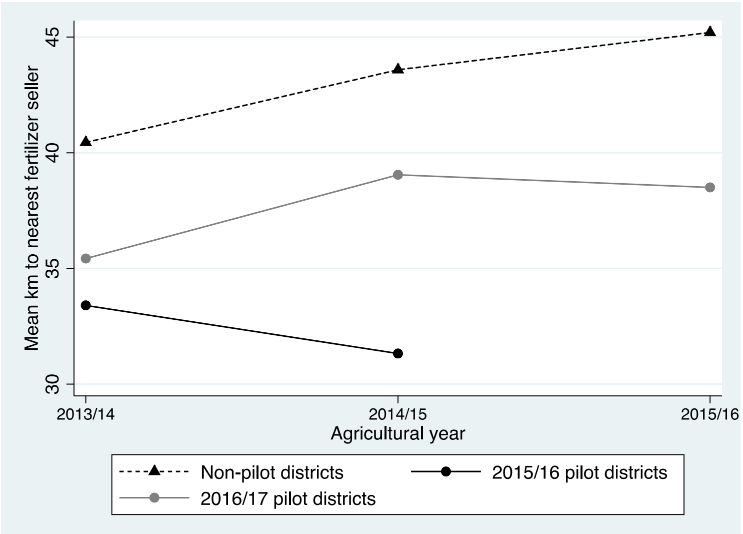


**Figure A1. Mean km to nearest fertilizer seller**

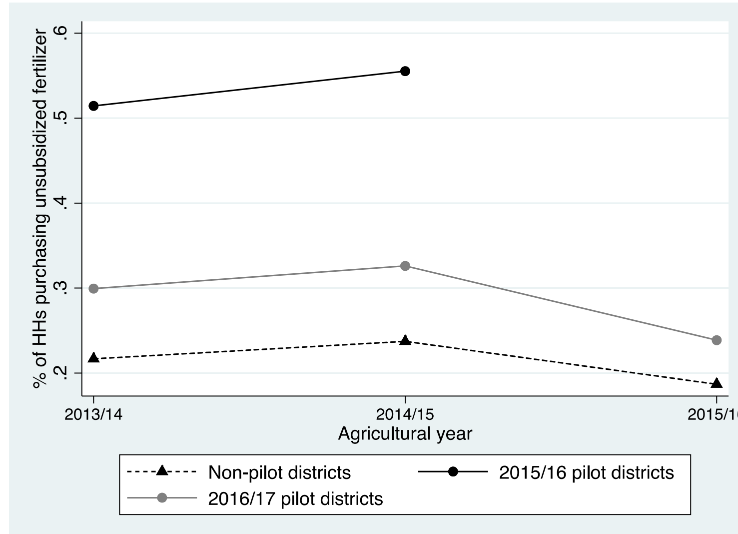


**Figure A2. % of households purchasing unsubsidized fertilizer**

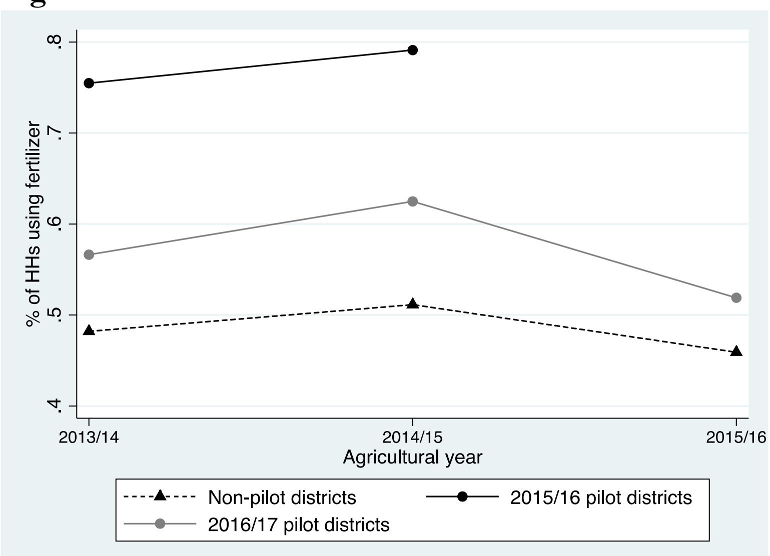


**Figure A3. % of households using fertilizer**

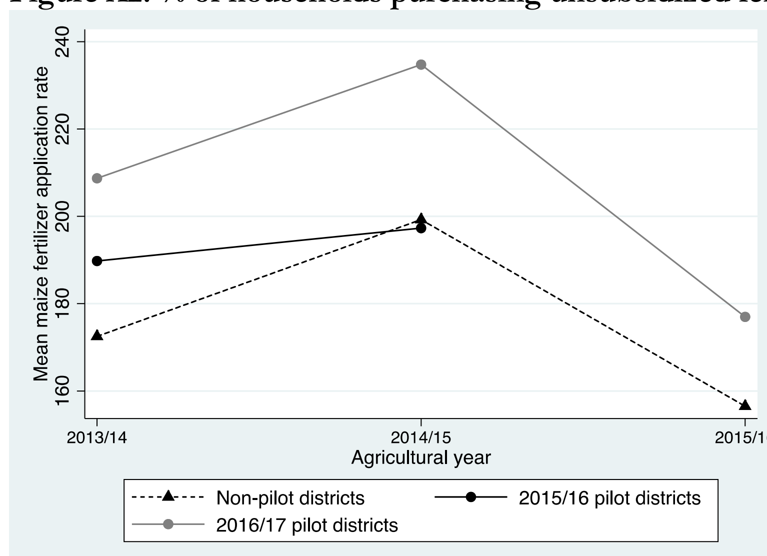


**Figure A4. Mean maize fertilizer application rate (kg/ha)**

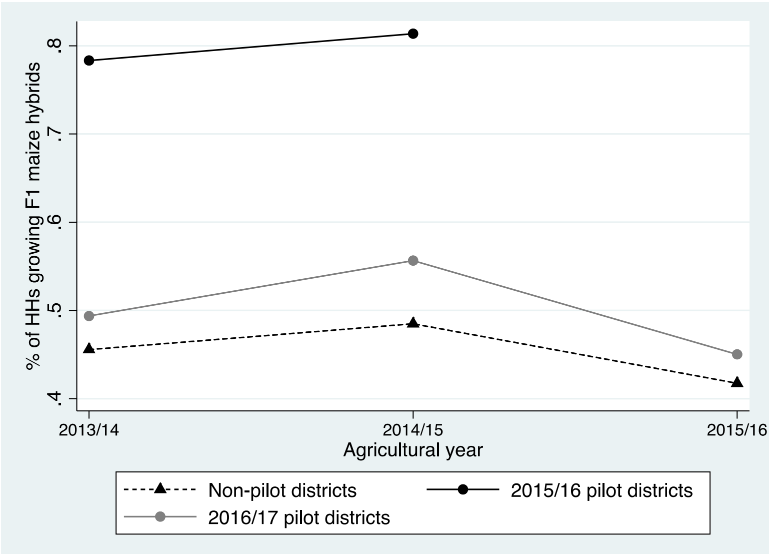


**Figure A5. % of households growing F1 maize hybrids**

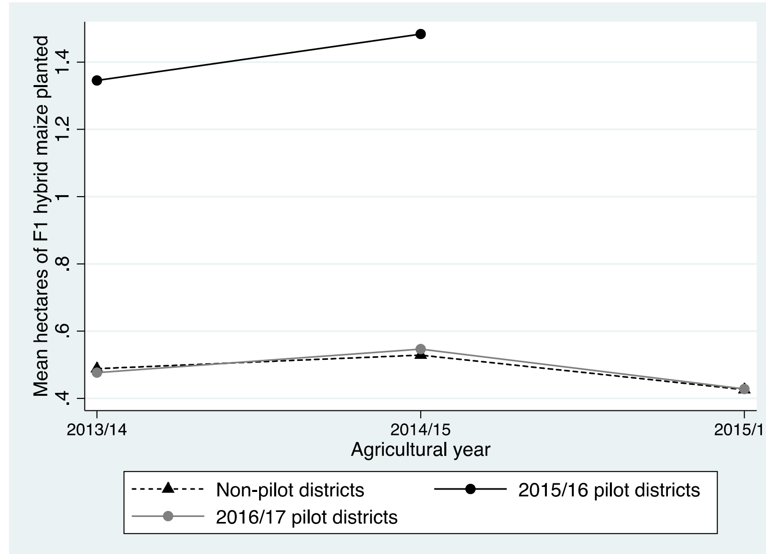


**Figure A6. Mean hectares of F1 hybrid maize planted**

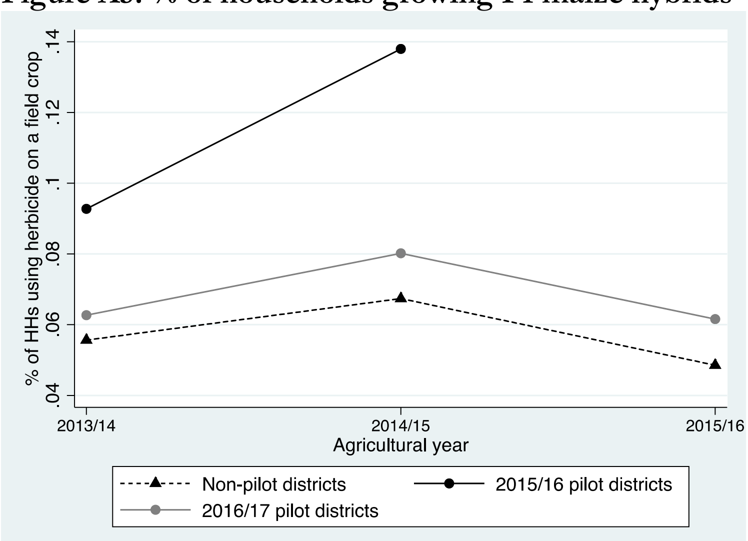


**Figure A7. % of HHs using herbicide on a field crop**

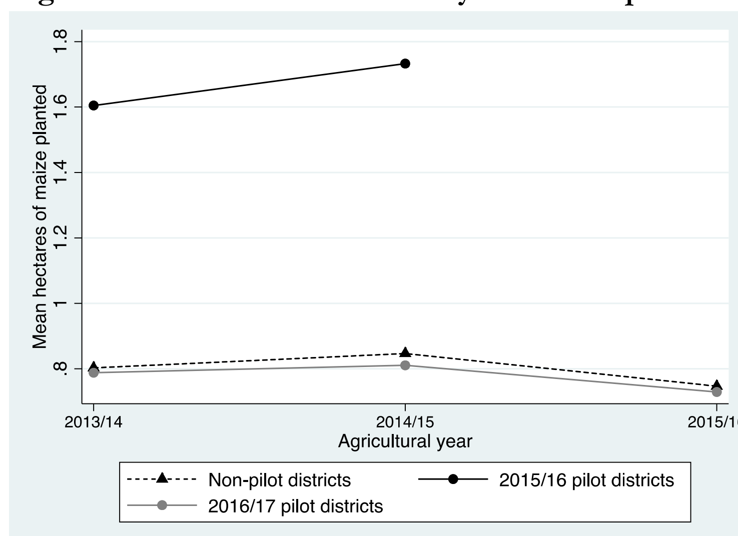


**Figure A8. Mean hectares of maize planted**

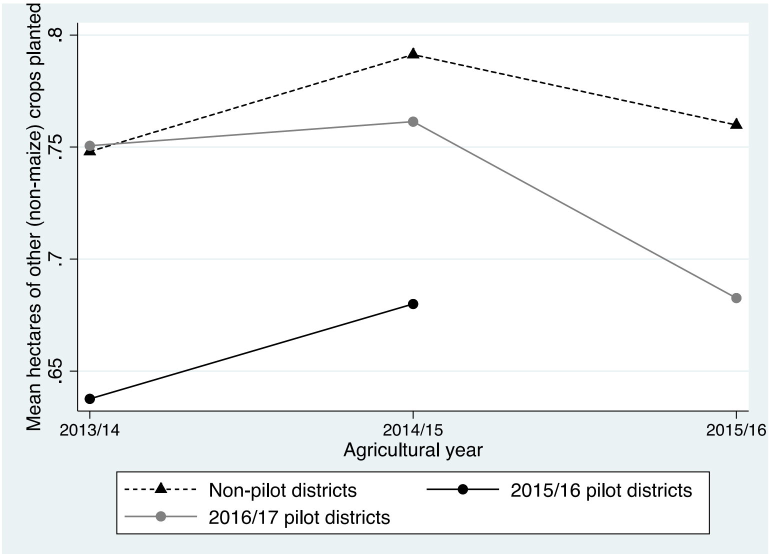


**Figure A9. Mean hectares of other crops planted**

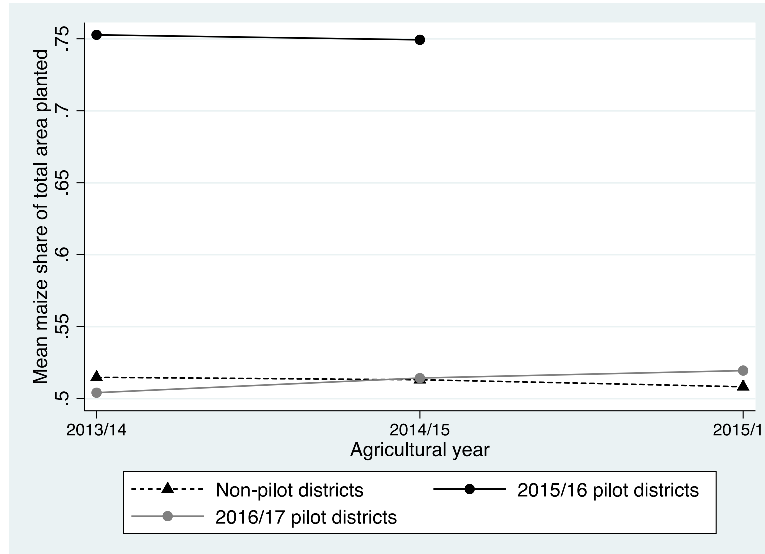


**Figure A10. Mean maize share of total area planted**

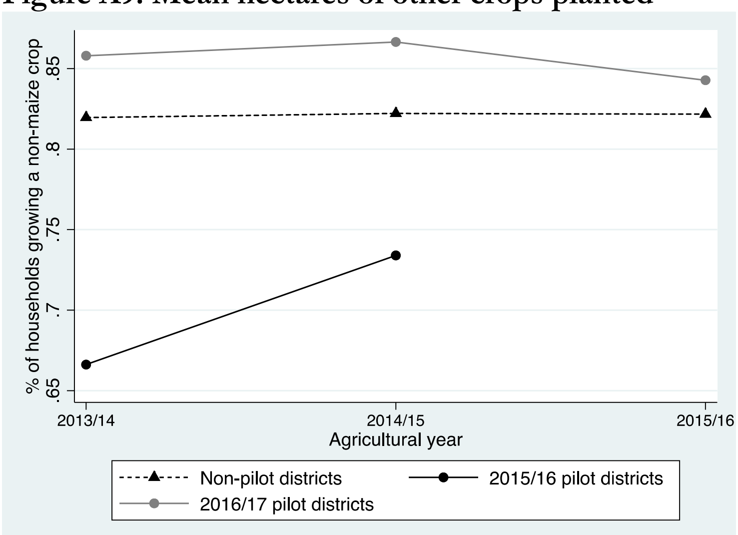


**Figure A11. % of households growing a non-maize crop**

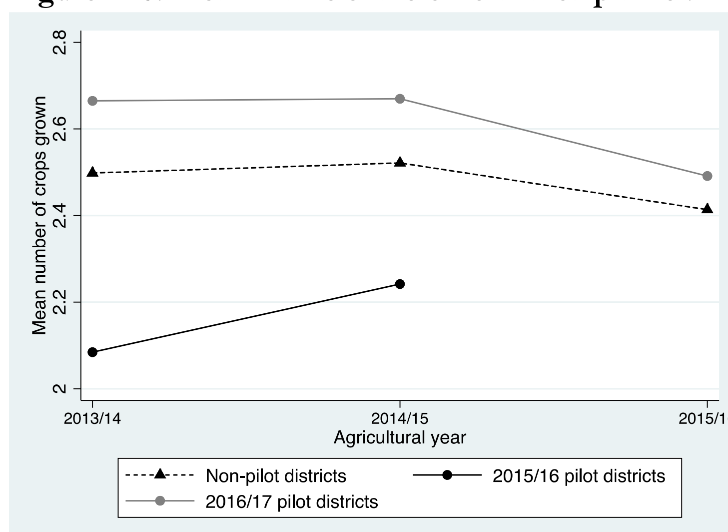


**Figure A12. Mean number of crops grown**

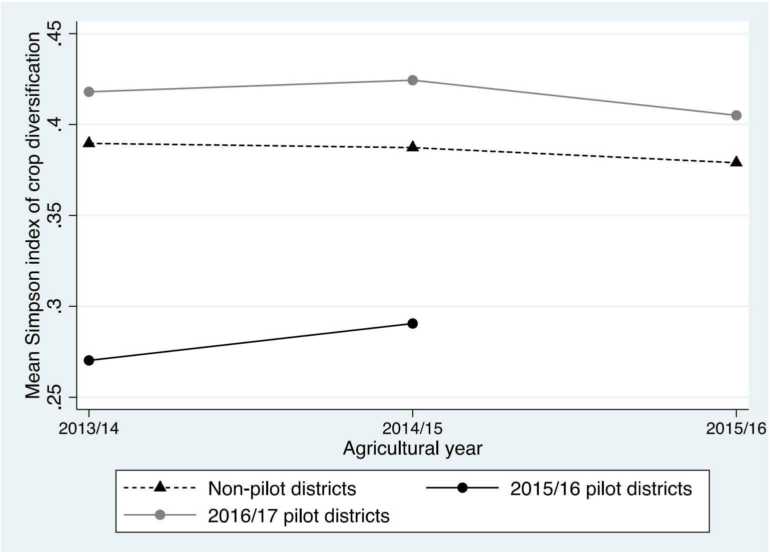


*Figure A13. Mean Simpson index of crop diversification*

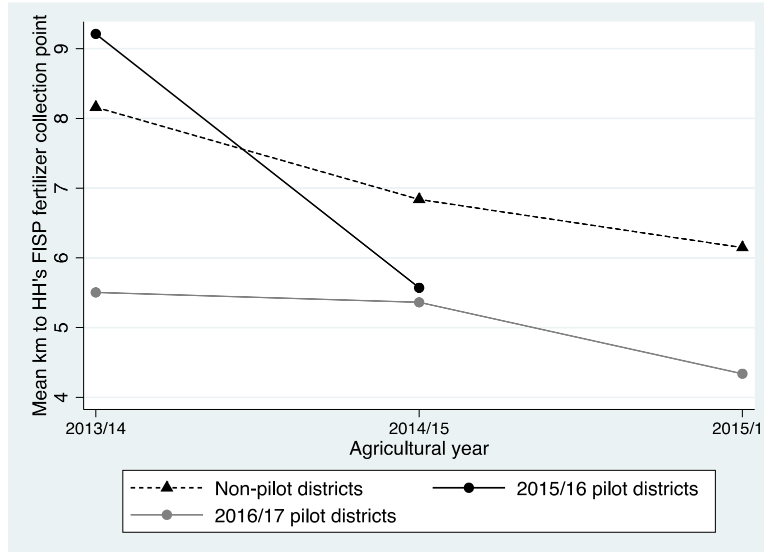


**Figure A14. Mean km to FISP fertilizer collection point**

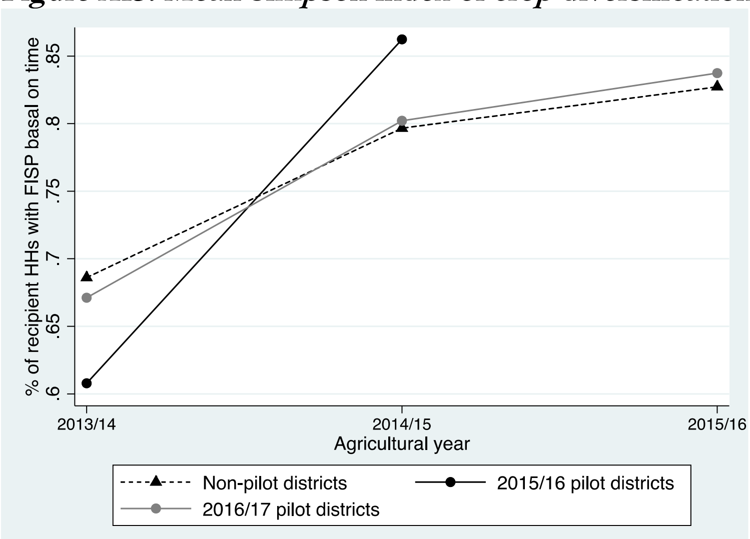


**Figure A15. % of recipients getting FISP basal on time**

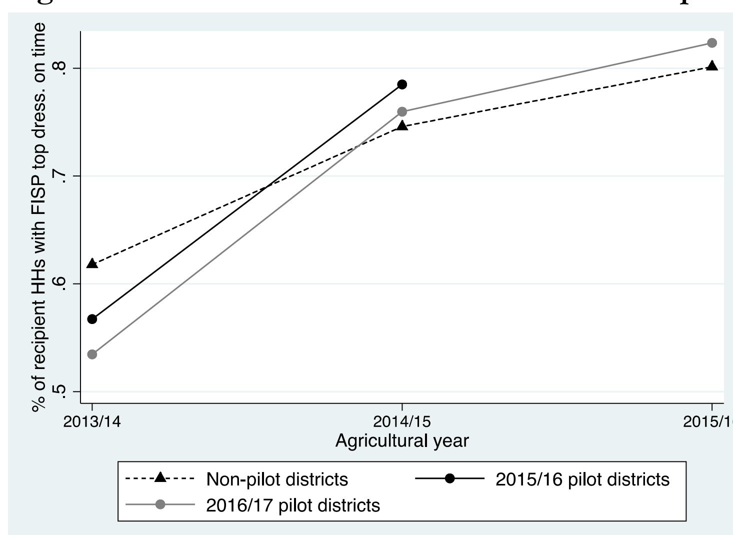


**Figure A16. % of recipients getting FISP top dressing on time**

**Table A6. Estimated effects of the shift to the FISP e-voucher in 2015/16 and 2016/17 on smallholder households' access to and use of modern inputs (including all districts)**

| Explanatory variables: | Km to the nearest fertilizer seller [a] | | | =1 if purchased unsubsidized fertilizer | | | =1 if used fertilizer | | | Maize fertilizer application rate (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | -2.18 | 1.79 | 1.79 | -0.039** | -0.027 | -0.028* | -0.035** | -0.037** | -0.038** | -12.69* | -18.50** | -17.73** |
| | (3.60) | (6.26) | (6.30) | (0.018) | (0.017) | (0.017) | (0.015) | (0.016) | (0.016) | (6.78) | (7.41) | (7.41) |
| District FE | X | X | X | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X | | | X |
| Observations | 39,678 | 39,671 | 38,259 | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 47,628 | 47,620 | 46,336 |
| R-squared | 0.173 | 0.179 | 0.190 | 0.148 | 0.171 | 0.185 | 0.242 | 0.272 | 0.288 | 0.246 | 0.256 | 0.272 |

| Explanatory variables: | =1 if grew F1 hybrid maize | | | Hectares of F1 hybrid maize | | | =1 if used herbicide on a field crop | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | -0.090*** | -0.078*** | -0.080*** | -0.16*** | -0.09*** | -0.09*** | -0.002 | 0.000 | 0.000 |
| | (0.022) | (0.021) | (0.020) | (0.03) | (0.03) | (0.03) | (0.007) | (0.006) | (0.006) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 |
| R-squared | 0.183 | 0.218 | 0.240 | 0.120 | 0.477 | 0.486 | 0.066 | 0.088 | 0.094 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls. The maize fertilizer application models are estimated for maize-growing households only.

Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table A7. Estimated effects of the shift to the FISP e-voucher in 2015/16 and 2016/17 on smallholder households' field cropped area and field crop diversification (including all districts)**

| Explanatory variables: | Hectares of maize | | | Hectares of non-maize field crops | | | Maize share of total field crops area planted | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | -0.07* | -0.01 | -0.01 | 0.10** | 0.03 | 0.02 | -0.026** | -0.001 | 0.001 |
| | (0.03) | (0.03) | (0.03) | (0.04) | (0.03) | (0.03) | (0.011) | (0.007) | (0.009) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,787 | 52,779 | 51,371 |
| R-squared | 0.159 | 0.630 | 0.635 | 0.111 | 0.288 | 0.291 | 0.366 | 0.380 | 0.399 |

| Explanatory variables: | =1 if grew at least one non-maize field crop | | | Number of field crops grown | | | Simpson index of field crop diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. | Coef. |
| $eFISP_{dt}$ | 0.011 | -0.008 | -0.012 | 0.11* | -0.00 | -0.01 | 0.021* | 0.003 | 0.002 |
| | (0.018) | (0.013) | (0.015) | (0.06) | (0.05) | (0.05) | (0.012) | (0.008) | (0.008) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 52,914 | 52,906 | 51,490 | 52,914 | 52,906 | 51,490 | 52,787 | 52,779 | 51,371 |
| R-squared | 0.156 | 0.183 | 0.191 | 0.186 | 0.263 | 0.268 | 0.212 | 0.256 | 0.263 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.

Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys

**Table A8. Estimated effects of the shift to the FISP e-voucher in 2015/16 and 2016/17 on smallholder households' distance to and timeliness of FISP fertilizer – among recipients only (including all districts)**

| Explanatory variables: | Km to the HH's FISP fertilizer collection point | | | =1 if FISP basal dressing was available on time | | | =1 if FISP top dressing was available on time | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** | **Coef.** |
| $eFISP_{dt}$ | 7.71*** | 6.40*** | 6.43*** | -0.173*** | -0.198*** | -0.197*** | -0.146** | -0.187*** | -0.187*** |
| | (1.30) | (1.28) | (1.29) | (0.052) | (0.052) | (0.052) | (0.056) | (0.062) | (0.061) |
| District FE | X | X | X | X | X | X | X | X | X |
| Year FE | X | X | X | X | X | X | X | X | X |
| Set #1 controls | | X | | | X | | | X | |
| Set #2 controls | | | X | | | X | | | X |
| Observations | 17,842 | 17,837 | 17,701 | 17,886 | 17,881 | 17,745 | 17,999 | 17,994 | 17,858 |
| R-squared | 0.052 | 0.063 | 0.064 | 0.125 | 0.163 | 0.165 | 0.114 | 0.161 | 0.163 |

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at the district level in parentheses. See Table 4 for definitions of Set #1 and Set #2 controls.
Source: Authors' calculations based on the 2013/14-2016/17 CSO/MoA Crop Forecast Surveys