Chapter 3

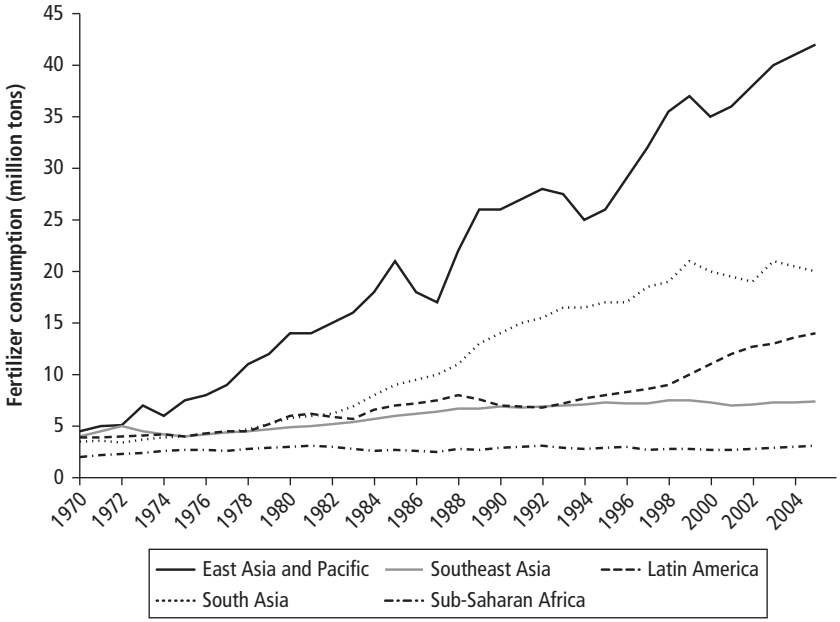
Smart Subsidies?

Of the many issues facing agriculture policy makers in Africa, one the most pressing is whether input subsidy programs—which have come to dominate agricultural budgets—are an effective way to raise productivity.[1] The gap is widening between agricultural productivity growth in Africa and the rest of the world. Closing this gap is a sine qua non to improve Africa's competitiveness on international markets and allow it to capture the rapidly growing regional market opportunities. Lagging productivity growth is attributed to the levels of modern input use, and Africa has by far the lowest rate of fertilizer use of any region, a rate that has practically remained the same over the last 40 years, despite considerable efforts by governments and donors to raise it (figure 3.1). The use of other yield-enhancing inputs—such as improved crop varieties, pesticides (herbicides, insecticides, fungicides), water control, and mechanization—is similarly limited. And in the absence of proper management techniques, yields are not sustainable in the long term on currently cultivated lands since soils are depleted of nutrients without proper agronomic practices.

African governments' commitment after the 2006 Abuja African Fertilizer Summit to increase fertilizer use from 8 to 50 kg of nutrients per hectare by 2015 reinforces the importance of inorganic fertilizer for increasing crop productivity and attaining food security in Africa. The impacts of achieving this target, however, will depend greatly on the agronomic efficiency of applied fertilizer. Many African governments' efforts to raise agricultural productivity have focused on programs to increase the volume of fertilizer used. Relatively little effort has been made in recent decades to help African farmers raise the efficiency of their fertilizer use.

Over the past decade, targeted input subsidy programs have been the main tool for many African governments to boost fertilizer use. In many countries, the programs have become the centerpiece of national agricultural development and food security strategies. While these programs have tended to produce important benefits for national food production and food security in the short run, the impacts have been attenuated by poor crop response to fertilizer use and to implementation features that depress the programs' contribution to overall fertilizer use more broadly. These limitations in turn have

Figure 3.1 **Fertilizer Use in Africa Lags behind Other Regions, 1970–2004**



Source: FAO, MAFAP database.

diminished the subsidy programs' contribution to poverty reduction and sustainable agricultural productivity growth, and in countries where these programs have been carefully examined, costs exceed benefits on average. Low crop response to fertilizer has also impeded the growth of commercial demand for fertilizer in Africa, and the subsidy programs have further crowded out the development of commercial distribution channels. There is strong evidence, however, that farmers will demand more fertilizer when they are able to obtain higher crop responses to fertilizer and make its use more profitable.

A more systematic strategy for raising smallholder crop productivity—focusing on sustainably raising the efficiency of fertilizer use as well as the quantity of fertilizer used—will more effectively achieve the region's agricultural, food security, and poverty reduction objectives. Such a comprehensive strategy may include input subsidy programs, if they can be implemented according to smart subsidy criteria, which has often proven difficult. Other and probably more important components of such an agricultural productivity strategy will include greater public investment in coordinated systems of

agricultural research and development, and water management and extension that emphasize bidirectional learning among farmers of varying resource constraints and agroecologies.

Sub-Saharan agricultural systems are undergoing rapid change in population densities, land scarcity, land degradation, climate variability, and new technologies. Because farming systems are dynamic, yesterday's best agronomic and crop management practices are unlikely to be suitable for today. Effective agricultural science and extension programs are thus necessary to interactively work with farmers to identify best practices to maintain and increase crop productivity in the face of these dynamic changes in the economic and biophysical environments. And because of substantial micro-level variation in these environments, effective crop science and extension systems must be "localized" to properly tailor agronomic best practices to heterogeneous environments.

While African governments' efforts to raise fertilizer use are laudable, spending on input subsidy programs *in most cases* appears to produce substantially smaller impact on national development objectives than their potential, and lower than the alternative ways of spending scarce resources. The gap between existing and potential impacts reflects both informational or knowledge constraints and political economy barriers. The contribution of input subsidy programs (and fertilizer use in general) to sustainable growth could be much greater with strong and sustained government commitment to complementary public goods investments as well as to government redesign of certain aspects of subsidy programs. But it is necessary to take a hard country-by-country assessment of the feasibility of achieving these outcomes in the foreseeable future.

This chapter investigates the extent to which inputs are underused, and attempts to close the knowledge gap on some of the key questions about the overall costs and benefits of input subsidy programs in the context of what is known more broadly about agricultural productivity growth. It identifies design features of these programs that make them cost-effective in meeting their goals. And it synthesizes evidence on the cost-effectiveness of other agricultural expenditures aimed at the same underlying objective as input subsidies—that is, raising productivity. The overall aim is to lay the groundwork for a more solid evidence-based dialogue on the subject.

Tipping the Balance

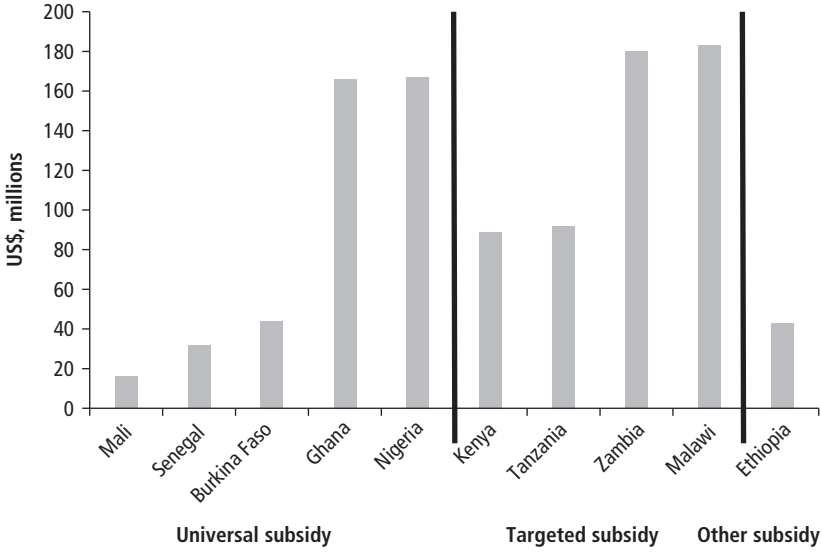
Fertilizer subsidy programs are among the most contentiously debated of development issues in Africa. Throughout the 1990s, input subsidy programs (ISPs) were largely phased out in Sub-Saharan Africa, and only two countries (Zambia and Malawi) continued to implement modest input subsidy programs sporadically over this period. Based on evidence from the 1980s and early 1990s,

a consensus emerged that fertilizer subsidy programs were largely ineffective in promoting African governments' development goals, contributing little to agricultural productivity growth, food security, or poverty reduction while placing a major fiscal burden on treasuries (Kherallah et al. 2002; Morris et al. 2007; World Bank 2008).

Fertilizer subsidy programs in Africa also tended to have adverse side effects, contributing to corruption and state paternalism, often hindering the development of commercial input distribution systems, and contributing to local supply gluts that put political pressure on governments to implement costly grain purchases and support price policies for farmers. For these reasons, international lenders and bilateral donors tended to discourage African governments from relying on input subsidy programs during this period of aid conditionality.

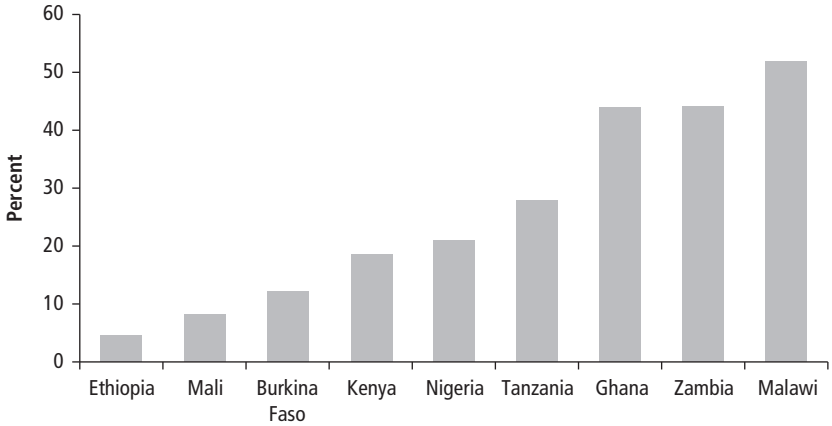
Starting in 2005, however, the landscape changed quickly and profoundly. Within several years after African governments committed to raise their expenditures on agriculture under the 2003 Maputo Declaration, at least 10 countries had introduced or reintroduced fertilizer subsidy programs costing roughly US$1 billion annually (figures 3.2 and 3.3).[2] Large-scale input subsidy programs often became the centerpiece of governments' agricultural development programs. Skepticism based on the past performance of these programs was swept

Figure 3.2 The 10 Largest African Programs Spend US$1.2 Billion a Year on Input Subsidies Alone



Source: Jayne et al. 2016.

Figure 3.3 Input Subsidy Program Cost as Share of Agricultural Spending, 2014



Source: Jayne et al. 2016.

aside by arguments that a new genre of smart subsidy programs could take account of past lessons to maximize the benefits and minimize the problems of prior programs.

How did this sea change occur so quickly? And what have we learned about this recent wave of input subsidy programs in Africa? Despite the proliferation of smart input subsidy programs, there has been limited rigorous evaluation of their impacts to date. Filling these knowledge gaps is the major motivation for this chapter. More specifically, the chapter has two main objectives. The first is to assemble the recent evidence on ISPs in Sub-Saharan Africa and to place this work in the broader literature on agricultural productivity growth. In so doing, we strive to shed light on two major questions:

- To what extent are ISPs evolving toward smart subsidy principles, especially by targeting beneficiaries and involving the private sector?
- What are the economic impacts of ISPs in Africa? Specifically, we address the effects of country-level ISPs on indicators such as total fertilizer use, national food production, the development of commercial input distribution systems, and the general equilibrium effects on food prices, wage rates, and poverty rates. We also assess whether ISPs are generating dynamic and enduring effects that kick-start broader growth processes or sustainable intensification in rural areas.

The chapter's second main objective is to identify ways that ISPs could more effectively achieve national policy objectives, given that many African

governments are likely to continue these programs, at least in the near future. This work focuses on potential changes in program design and implementation as well as complementary public expenditures and policies that assist farmers in raising the efficiency of input use. These two objectives are addressed through comprehensive reviews of the micro-level evidence in seven countries where input subsidy programs have featured prominently (Ethiopia, Ghana, Kenya, Malawi, Nigeria, Tanzania, and Zambia).[3] We also draw from recent multicountry assessments of ISPs in Africa (Druilhe and Barreiro-Hurlé 2012; Jayne and Rashid 2013; Wanzala-Mlobela, Fuentes, and Mkumbwa 2013). The annexes are a comprehensive compendium of virtually all recent empirical evidence from research on the impacts of ISPs, organized by major issue.

Given the rapid evolution of ISP design and implementation, many knowledge gaps remain. ISPs in Rwanda, Burundi, and Nigeria, for example, are undergoing design changes to incorporate lessons from prior assessments and overcome weaknesses, leading to continual refinement over the past decade. Efforts in several countries have been made to ensure that ISPs are now "smarter" and more effective than in prior years. Moreover, the evidence base on ISPs and smallholder crop response to fertilizer is expanding rapidly. The growing availability of farm panel survey data—combined with soil sample data, advances in estimation methods, and innovations in survey design methods—have enhanced economists' ability to identify program effects with greater precision. This chapter provides an updated review of evidence over the past decade, but both the continued lack of evidence about program impacts in some areas and the conflicting evidence in others pose challenges for consensus building. Even so, the weight of the empirical studies does point in clear directions on some key points.

Rationale for Input Subsidy Programs

Most rural African settings suffer from multiple market failures, providing an important entry point for subsidies to address the constraints faced by economic agents, especially poor farmers. Welfare economics has long recognized the potential usefulness of subsidies in situations in which social benefits exceed private benefits (due to market failures or externalities). Subsidies can also be justified under specific circumstances—for example, when there are strong learning-by-doing effects, strategic trade intervention opportunities, or environmental benefits, as well as for equity considerations (Morris et al. 2007; World Bank 2008).

In primarily agrarian economies, low levels of inorganic fertilizer use are associated with low crop yields, low rural incomes, and high poverty rates. Dorward, Hazell, and Poulton (2008) present a conceptual framework that

describes African rural economies as being in a productivity-poverty trap, from which risk-averse farm households are unable to extricate themselves. Input use remains low in equilibrium with low productivity, reinforcing staple crop self-sufficiency goal and stifling diversification into other agricultural and nonagricultural activities. The trap impedes rural people's ability to protect themselves from shocks, and hampers wider local and national economic development, resulting in a vicious cycle. Unstable food prices inhibit producers' net investment in staple production, reduce consumers' willingness to rely on the market for staple purchases, and limit consumers' opportunities to escape from low productivity staple cultivation. These in turn inhibit the growth of the nonfarm economy.

Relieving these constraints through input subsidy programs can not only help affected farmers but also potentially unleash strong general equilibrium impacts—boosting agricultural productivity and incomes; lowering food prices; raising real wages, employment, and broader economic growth through forward and backward linkages; and strongly contributing to poverty reduction. Because staple crops account for such a large proportion of total cultivated area in most African countries, smallholder staple crop productivity growth is likely to generate dynamic growth processes that will lead to agricultural diversification and farm-nonfarm growth linkages and employment effects that contribute to economic transformation and poverty reduction.[4]

By raising crop yields dramatically for several years in a row, fertilizer subsidy programs have the potential to kick-start dynamic growth processes that allow households to break out of the trap and move onto a higher productivity and income growth trajectory. Eventually, recipients may generate cash savings that enable them to invest in productive farm equipment and purchase commercial fertilizer. These investments in complementary farm assets and inputs sustain farmers' upward productivity growth trajectory. If millions of small farms experience such growth, it could lower food prices, increase demand for agricultural wage labor, and increase circulation of money in rural areas that generate multiplier effects—all contributing to employment and economic growth. In these ways, fertilizer subsidy programs are argued to be a powerful tool for transforming agrarian societies and kick-starting broader structural transformation processes.

Other motivations for fertilizer subsidy programs in Africa have focused on a "learning effect." Fertilizer use may be inadequate in some areas because farmers have no experience with it. A subsidy on fertilizer could enable farmers to gain valuable information about the benefits of using fertilizer without risking a major capital outlay (Carter, Laajaj, and Yang 2014). After learning about the benefits of using fertilizer, farmers may then continue to purchase it after the subsidy program ends. Such a learning effect would be confined to areas where fertilizer use is uncommon but likely to be profitable.

A frequently articulated argument for input subsidy programs in Africa is that many developed countries have implemented them for decades to build up their agricultural sectors, and there is no reason why countries in Africa should not enjoy the same benefits. This view assumes that input subsidy programs in developed countries actually contributed to those countries' development, or that they were a more effective use of public resources than other public investments such as investments in technological improvements, farmer education, infrastructural development, and irrigation. However, we are not aware of empirical research to support these positions. Studies from Asia, for example, found that fertilizer subsidy programs were quite far down on the rankings of public expenditures with respect to cost-effective impacts on agricultural productivity growth and poverty reduction (EIU 2008; Fan, Gulati, and Thorat 2008). A comprehensive review of these studies is discussed in the previous chapter.

Reasons for Low Fertilizer Use: Is It Really "Too" Low in Africa?

While there are varied motivations for fertilizer subsidy programs, all are based on the assumption that existing fertilizer use in Africa is "suboptimal." The causes of low fertilizer use are often considered to be related to the following:

- Households' insufficient access to credit to purchase fertilizer in quantities even close to official recommendations, if at all
- Households' lack of information about the benefits of using fertilizer
- Risks of using fertilizer—even if fertilizer use is expected to raise net household income on average, the risk of a loss discourages use
- Weak development of commercial input markets
- Price volatility in output markets, which deters farmers from purchasing inputs to produce a marketable surplus

Of all the reasons for low fertilizer use in Africa, the expected profitability of using fertilizer typically is rarely questioned. Instead, in many areas of Africa, fertilizer is shown to be highly valued by farmers, and studies demonstrate high financial returns to most farmers. However, there appears to be a selection bias in the literature on farmer returns to fertilizer use in Africa. Studies tend to be concentrated in areas where fertilizer use is already common and fairly high. Moreover, prior to 2005, analysts' main source of fertilizer response estimates for African smallholder farmers came from experimental stations or on-farm trials. But on-farm trials tend to be managed by scientists in heavily controlled environments for seed type, planting date, row spacing, seed spacing, weeding, and even the choice of farmer to participate. Few nationally representative smallholder farm panel data sets were available to understand staple crop response to fertilizer on fields that were managed by smallholder farmers and accounting for the various resource constraints that they faced.

While on-farm trials are generally considered to provide accurate estimates of the crop response rates to fertilizer that farmers *may get* under near ideal conditions on well-managed plots, they are often not representative of the response rates that smallholder farmers *do get* when they follow the management practices they often employ given the various resource constraints they face. Farm trials often involve farmers on a nonrandom basis. They tend to be disproportionately "master farmers" who possess better management practices and encounter fewer constraints. Cases of crop damage from drought, flooding, pests, or disease are often dropped from trials, even though these are real possibilities for farmers purchasing inputs in the real world. Trial plots tend to be carefully chosen for suitability and are generally smaller than most farmer-managed plots, providing greater "edge effects" that likely raise crop responses to fertilizer.

For these reasons, it is likely that prior estimates of crop response rates (or nutrient use efficiency, hereafter NUE) from researcher-managed farm trials in Africa provide potentially misleading estimates of fertilizer use profitability. Our understanding of the economics of fertilizer use needs to be updated based on observations from farmer-managed fields. Since roughly 2005, a growing number of studies have begun estimating crop response rates to fertilizer based on increasingly available panel surveys of smallholder farmers. Farm panel surveys are arguably the most accurate source of obtaining estimates of the NUE that farmers obtain in their fields for many reasons:

- Many are nationally representative and are thus more representative of the population than trials, many of which are in high-potential areas.
- They take into account farmers' actual behavior and resource constraints ("farmer managed plots" as opposed to "researcher-managed plots").
- Panel survey data are better able to control for the effects of unobserved time-invariant factors correlated with fertilizer use, which might otherwise bias researchers' estimates of NUE in cross-sectional data.
- From an ex ante framework of the farmer deciding whether to purchase and apply fertilizer to a particular field, survey data that retain cases of crop damage, floods, striga (parasitic weed), and shocks leading to inadequate labor, for example, represent valid cases that need to be included in estimations of on-farm averages for NUE.[5]

The evidence on "researcher-managed" farm trials in East and Southern Africa produced NUE estimates ranging from 18 to 40 kg of maize per kg of nitrogen (Tscharntke et al. 2012; Vanlauwe et al. 2011). Until recently, this was the range of NUE commonly believed to hold for smallholders' own fields using their own management practices. Given prevailing fertilizer and farmgate maize prices in the region, nitrogen use efficiency estimates in the range of 18–40 kg

of maize per kg of nitrogen almost always show highly profitable returns to farmers. By contrast, table 3.1 shows our inventory of recent survey-based estimates of NUE from studies based on farmer-managed fields.

The estimates in table 3.1 consistently find response rates in the range of 8–24 kg of maize per kg of nitrogen applied, with a concentration at the lower end around 8–15 kg. These studies suggest that smallholder households obtain levels of crop response that generally are substantially lower than those estimated from researcher-managed on-farm trials.

Indeed, if the cause of low fertilizer use is low profitability, this implies that the net value of output produced from incremental fertilizer use may not exceed the social cost of the additional fertilizer (box 3.1). Under such conditions, it is not clear that increased fertilizer use will enhance economic efficiency or productivity goals until crop response rates to fertilizer use are increased (box 3.2).

Why Is the Crop Response Rate So Low in Africa?

Both the mean and variance of crop response rates vary greatly between irrigated and rainfed conditions. Water control is a fundamental "game changer" for the economics of fertilizer use. Roughly 45 percent of South Asia's grain crops are under irrigation, which typically affords two to three cropping seasons per year and relatively stable yield responses to fertilizer. Consequently, fertilizer application rates on cereal crops are substantially higher on irrigated fields than on rainfed plots).[6] By contrast, 96 percent of Sub-Saharan Africa's cultivated land is rainfed, much of it in semiarid areas experiencing frequent water stress and with one crop season a year.

Fertilizer application rates on rainfed fields in India are also quite low and not different from application rates in much of rainfed Africa (Rashid 2010). Water control may be an increasingly important determinant of fertilizer use rates in the future, with more variable climate conditions. For these reasons, the economics of fertilizer use in Africa are generally less favorable than in other regions of the world where water control is more common. The water constraint on fertilizer use can be relieved, albeit to a limited extent and only with investments over a significant period.

Soil quality is another massive challenge that African farmers face in raising crop responses to fertilizer. The availability of 17 essential nutrients (or elements) ultimately determines a plant's growth and the yield potential of food crops (Jones et al. 2013).[7] The efficiency of fertilizer use depends on the level of preexisting *available* nutrients stocked in the soil as well as the *availability* of nutrients applied as fertilizer. Part of what determines nutrient availability is the soil characteristics that represent the physical, biological, and chemical properties of soils. There are numerous ways to measure each of them, but common metrics include pH (soil chemistry), soil organic matter (soil biology),[8] and texture (soil physics).

Table 3.1 Recent Estimates of Fertilizer Application and Response Rates in Sub-Saharan Africa

African study areas (sources)	Geographic focus	Maize fields receiving commercial fertilizer use (%)	Application rate for users	Estimated nitrogen use efficiency (kg output per kg N)	Estimated value-cost ratio (VCR)
Sheahan, Black, and Jayne (2013)	20 districts of Kenya where maize is commonly grown, 5 years of data between 1997 and 2010	64 (1997) to 83 (2007)	26 kg N/ha (1997) to 40 kg N/ha (2010)	AP = 21 kg maize/kg N MP = 17 kg maize/kg N	AVCR=1.3 (high-potential maize zone) to 3.7 (eastern lowlands)
Marenya and Barrett (2009)	Kenya (Vihiga and S. Nandi districts); relatively high-potential areas	88 (maize and maize/bean intercrop)	5.2 kg N/ha	MP = 17.6 kg maize/kg N	MVCR=1.76 (but fertilizer was <1.0 on 30% of plots)
Matsumoto, Yamano, and Sserunkuuma (2012)	100 locations in Western and Central Kenya (2004, 2007)	74	94.7 kg fertilizer product/ha maize	MP = 14.1–19.8 kg hybrid maize/kg N	MVCR=1.05–1.24 for hybrid maize
Snapp et al. (2014)	Malawi–nationally representative LSMS survey data	27 (maize plots)	62.9 kg/ha maize	5.33 for monocrop; 8.84 for intercropped maize	MVCR=1.04–1.38 AVCR=1.25–1.71
Morris et al. (2007)	W/E/S Africa	—	—	E/S Africa: 14 kgs maize/kg N (median) W Africa: 10 kg maize/kg N (median)	E/S Africa: 2.8 W Africa: 2.8
Minten, Koru, and Stifel (2013)	Northwestern Ethiopia	69.1 of maize plots fertilized	65.3 kg N/ha	MP=12kg maize/kg N for on-time planting; 11 kg maize/kg N for late planting	1.4–1.0 (varying by degree of remoteness)
Pan and Christiaensen (2012)	Kilimanjaro District, Tanzania	—	—	11.7 kg maize/kg N	—
Xu et al. (2009)	AEZ IIa in Zambia (relatively good quality soils/rainfall suitable for maize production)	56.4 on maize	61.4 kgs N/ha (among users)	AP = 18.1 (8.5–25.5) MP = 16.2 (6.9–23.4)	Accessible areas=1.88 Remote areas=1.65

(continued next page)

Table 3.1 (continued)

African study areas (sources)	Geographic focus	Maize fields receiving commercial fertilizer use (%)	Application rate for users	Estimated nitrogen use efficiency (kg output per kg N)	Estimated value-cost ratio (VCR)
Burke (2012)	Zambia (nationally representative), 2001, 2004, 2008	36–38 of maize fields; 45–50 of maize area	35.2 N/ha maize	9.6 kg maize/kg N	0.3–1.2 depending on soil pH level for 98% of sample
Ricker-Gilbert and Jayne (2012)	Malawi national panel data	59 of maize fields	47.1 N/ha maize	8.1kg maize/kg N	0.6–1.6
Chibwana, Fisher, and Shively (2012)	Malawi farmer-managed field data in Kasumgu and Machinga Districts		—	9.6–12.0 kg maize/kg N	MVCR 1.4–1.8
Chirwa and Dorward (2013)	Malawi national LSMS survey data	—	—	Negative to 9.0	Below 2.0
Liverpool-Tasie and Takeshima (2015)	Nigeria national LSMS survey data	—	—	8.0 kg maize/kg N	Below 2.0
				8.8 kg rice/kg N	Below 2.0
Mather et al. (2015)	Tanzania national LSMS-ISA survey data	15.9 (2009) 20.6 (2011) 17.9 (2013)	55.6 N/ha maize	7.8 kg maize/kg N (highlands) 5.7 kg maize/kg N	MVCR 0.94–1.23 (varies by year) MVCR 0.71–1.08

Note: Given prevailing commercial retail input and output price ratios, we (or the studies' authors) calculate either the expected MP and AP and, subsequently, the expected MVCRs and AVCRs of the following forms:

$$E(MVCR_{fijt}) = \frac{E(p_{yijt}) * E(MP_{xijt})}{W_{fijt}}$$

$$E(AVCR_{fijt}) = \frac{E(p_{yijt}) * E(AP_{xijt})}{W_{fijt}}$$

in which w_f is the price of fertilizer, p_y is the producer price of the crop in question, *i* indexes individual farms, *j* indexes their fields and t indexes time, and E indicates average or expected.

AEZ = agroecological zone; AP = average physical products; AVCR = average value-cost ratio; LSMS-ISA = Living Standards Measurement Study—Integrated Surveys on Agriculture; MP = marginal physical products; MVCR = marginal value-cost ratio; VCR = value-cost ratio; W/E/S = West/East/South; — = no estimates.

BOX 3.1

Are Response Rates High Enough to Incentivize Farmers to Increase Fertilizer Use?

An expected average value-cost ratio (AVCR) of greater than 1 suggests that a farmer expects to increase his income as a result of fertilizer use (the average gain per unit). An expected marginal value-cost ratio (MVCR) of greater than one indicates income would be expected to increase with an increase in the rate of fertilizer application. But African smallholder farmers tend to be risk-averse, and the inclusion of a risk premium is important to measure the relationship between the VCRs and farmer adoption behavior (Anderson, Dillon, and Hardaker 1977). Moreover, farmers incur other costs associated with fertilizer use that are unaccounted for in VCR measures, such as increased weeding labor needed on fertilized plots because the fertilizer contributes to weed growth that competes with plants for the nutrients. Farmers may also incur transaction costs of obtaining inputs and selling crops that are not accounted for in w_f and p_y.

For these reasons, an AVCR of 2 has been typically used in the literature as the benchmark for reliably profitable adoption (Bationo et al. 1992; Sauer and Tchale 2009; Xu et al. 2009).[a] This dates back to work by the FAO (1975) to better accommodate risk and uncertainty, adjust for the many unobserved costs associated with fertilizer use, and serve as an approximation for the rate at which fertilizer is profitable *enough* for smallholder farmers to want to use it.

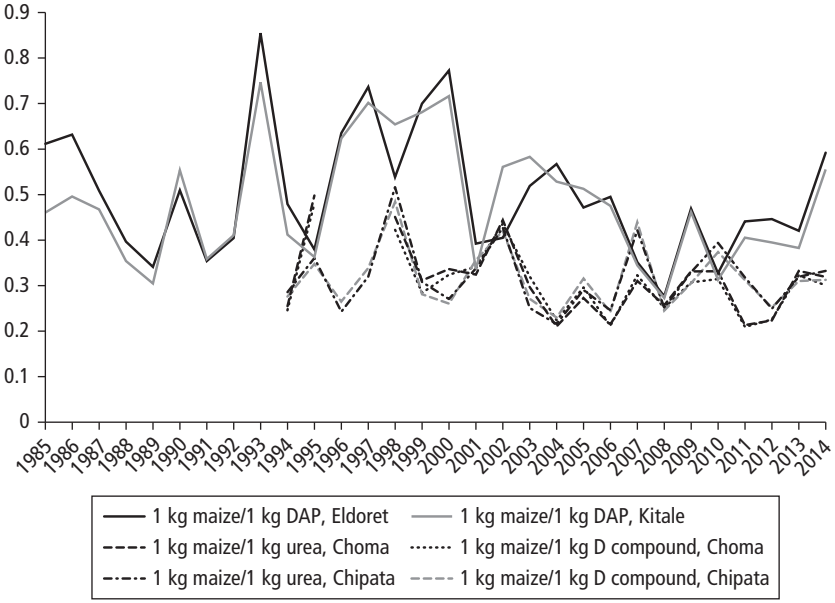
The VCR estimates in the far right column of table 3.1 show very few cases over 2.0. Most of the estimates fall between 1.0 and 2.0, signifying marginal or moderate profitability when risk and other unmeasured costs are not taken into account. The growing evidence that low fertilizer use is at least partially driven by low response rates on many African soils suggests that if response rates are not high enough to provide incentives to use inorganic fertilizers, a rational farmer's efficient choice would be to not adopt it.

Another important point is the makeup of the VCR calculations in equations (3.1 and 3.2): using input prices, output prices, and input productivity. Despite the efforts of subsidy programs, the fact remains that the ratio of these prices, while volatile, has been fairly constant on trend. This includes various maize-to-fertilizer price ratios for locations throughout Zambia and Kenya (figure B3.1.1). The majority of trends in these ratios (not shown) are essentially flat and *no ratio trend is statistically positive* (or negative) over time. If the ratio of grain-to-fertilizer prices continues with a zero trend for the foreseeable future, this would indicate that shifts over time in fertilizer profitability must be driven by changes in response rates.

(continued next page)

Box 3.1 (continued)

Figure B3.1.1 Various Maize-to-Fertilizer Price Ratios for Zambia and Kenya, 1985–2004



Source: Jayne et al. 2016.

a. This dates back to work by the FAO (1975) to better accommodate risk and uncertainty, adjust for the many unobserved costs associated with fertilizer use, and serve as an approximation for the rate at which fertilizer is profitable *enough* for smallholder farmers to want to use it. In recent data, it becomes possible to account for some farm-specific costs (such as transportation) in which case the VCRs considered profitable would be lower than 2. By how much is unfortunately still dependent on unobservable factors, so there is no "rule of thumb" for estimates accounting for farmgate pricing; we simply accept that "2" is an increasingly pessimistic choice. It is, however, recommended to discuss the *distribution* of VCR estimates so that readers can make their own assessments as well.

BOX 3.2

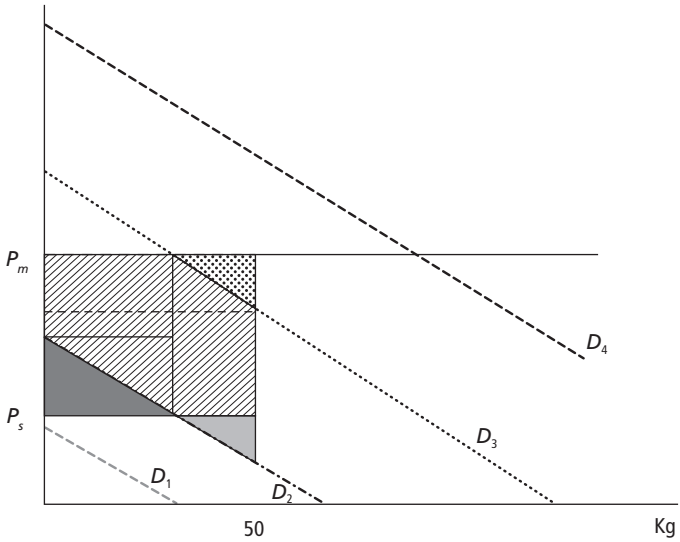
Welfare Effects of the Malawi Farm Input Subsidy Program

The Malawi Farm Input Subsidy Program (FISP) is perhaps the most publicized of the current generation of smart subsidies in Africa, and the inspiration for many of them. Smart ISPs typically provide farmers with vouchers to purchase small quantities of fertilizers (and sometimes seeds) at a subsidized price less than market value. FISP's impacts have

(continued next page)

Box 3.2 (continued)

Figure B3.2.1 Four Categories of Farmer Demand for Fertilizer



Source: Jacoby 2016.

been analyzed in numerous studies, including some that estimate costs and benefits of the program. To our knowledge, however, none of these analyses have explicitly recognized that the aggregate benefits of this kind of program depend on the differing benefits accruing to farmers in terms of consumer surplus. The classes of farmers correspond to the four demand schedules in figure B3.2.1. For each of them, the cost of the subsidy program is the difference between the commercial price (the price paid by the government) and the subsidized price, times the amount of fertilizer purchased by the farmer. The net benefit of the subsidy is the difference between the consumer surplus and the cost.

The consumer surplus is different for each class of farmer:

- *Class 1* comprises those with a demand for fertilizer so low that they are not willing to buy fertilizer at the subsidized price even if it is possible to purchase in fractions of 50 kg bags. These farmers get no benefits, but also incur no costs to the program.
- *Class 2* includes those who would not purchase any fertilizer at the commercial market price, but have a demand high enough to make it worthwhile to buy the full 50 kg bag at the subsidized price, even though they would prefer to purchase only a fraction of a bag. The net welfare gain to this class of farmer from the subsidy is represented by the area of the solid darker gray triangle minus the area of the solid light gray triangle.
- *Class 3* encompasses those who would purchase some fertilizer (but not a full bag) at the market price, but would willingly purchase a full bag at the subsidized price. As in

(continued next page)

Box 3.2 (continued)

class 2, the subsidy in class 3 induces the farmer to procure more fertilizer than she otherwise would. But the marginal value of these additional units to the farmer is less than the cost of providing them. This difference is represented by the cross-hatched triangle in the upper right of the figure.

- *Class 4* covers farmers for whom the subsidy is inframarginal—that is, they would buy more than one bag at the full market price. Here, the subsidy does not change farmer behavior at all, so the welfare gain, the entire rectangle (cross-hatched area plus the lower solid dark gray triangle), is equal to the cost of the subsidy.

Using data from the 2013 household survey (Jacoby 2015), which included information on FISP voucher receipts and redemptions, the study estimated demand for each type of fertilizer using data for nonrecipients of vouchers. The demand schedule was conditional on household characteristics and various measures of soil quality, which is a critically important determinant of the value of fertilizer. Using this information, and information on voucher redemptions by households that received them, the study estimated how many farms fall into each of the four classes and the net benefits (consumer surplus minus cost) for each of the households. It turns out that few farmers were predicted to be in class 1 or class 4, and about 73–75 percent (depending on the type of fertilizer) were in class 3.

Benefit-cost ratios were estimated for each household under two assumptions: one was that the household's demand for fertilizer was not constrained by lack of access to credit; the other was that the demand was credit-constrained, in which case the estimated benefit of the subsidy was higher. The unconstrained demand estimate assumed that all households value fertilizer as though they were in the 90th percentile of the per capita expenditure distribution.

The key finding is that benefit-cost ratios are well below 1 (table B3.2.1), the upper bound achieved when all households are inframarginal with respect to the FISP. For the consumer surplus computed based on constrained demand, the national benefit-cost ratio is only 0.41, which means that 59 percent of every kwacha spent on FISP is wasted. The poor account for much more of this deadweight loss than the nonpoor for the simple reason that the poor have a lower demand for fertilizer. Obviously, moving from constrained to unconstrained demand as a basis for computing the consumer surplus attenuates the difference in benefit-cost ratios between the

Table B3.2.1 Benefit-Cost Ratios for the Malawi Farm Input Subsidy Program

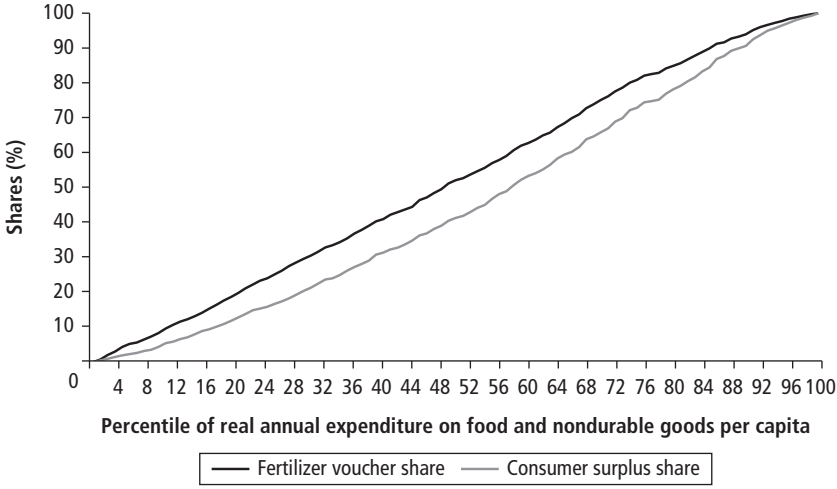
	Constrained demand	Unconstrained demand
All agricultural households	0.41	0.62
Poor agricultural households	0.29	0.53
Nonpoor agriculture	0.46	0.46

Source: Jacoby 2016.

(continued next page)

Box 3.2 (continued)

Figure B3.2.2 Share of Net Benefits According to Expenditure Bracket, Based on Unconstrained Demand



Source: Jacoby 2016.

poor and the nonpoor, although in reality the assumption of credit constraints is likely to be more realistic for the poor.

As a final step, the study estimated benefit incidence curves for the FISP, showing what percentage of the benefits (consumer surplus) accrued to each expenditure bracket percentile. Figure B3.2.2 shows the curve based on unconstrained fertilizer demand. In the figure, the naïve curve is plotted, which is just the share of vouchers that actually went to the bottom k^{th} percentile of the per capita expenditure distribution. Evidently, FISP voucher distribution does not effectively target the poor; indeed, there is no discernible progressivity in the distribution of vouchers. However, when the actual estimated benefit due to the voucher is taken into account, the FISP appears much more regressive, which again is attributable to the low demand for fertilizer among the poor.

Several important points emerge from this analysis. First, notwithstanding the "smart" features of the FISP, the program is not progressive. Second, the program is inefficient, in the sense that its cost is considerably more than its value to recipients. Finally, the results demonstrate a tension between the two objectives often cited for input subsidies for inframarginal farmers: boosting agricultural production and reducing poverty.

Research in the fields of agronomy, soil science, and farming systems ecology is pointing the way to how sustainable intensification will need to occur in rainfed Sub-Saharan Africa and the role of fertilizer in these systems (Powlson et al. 2011; Snapp and Pound 2011; Vanlauwe et al. 2011). A substantial body of evidence documents how rising rural population density in much of Africa is leading to rising land pressures, reduced fallows, more continuous cultivation, soil degradation, and weaker responses to fertilizer application over time (Drechsel et al. 2001; Roy et al. 2003; Tittonell and Giller 2013). Declining soil fertility is an important factor causing stagnant or declining trends in maize-fertilizer response rates observed over time, even while hybrid seed adoption is on the rise.

Smallholder farmers are largely unable to benefit from the current yield gains offered by plant genetic improvement due to their farming on depleted soils that are nonresponsive to fertilizer application (Giller et al. 2006; Tittonell et al. 2007). The efficiency with which fertilizer nutrients affect crop yield is strongly reduced by soil degradation (nutrient loss, too high or too low pH, or lower soil organic matter).[9] Sustainable intensification efforts can be thought of in relation to three categories of fields: responsive to fertilizer use, nonresponsive but still productive, and nonresponsive and degraded. Rising population pressures and more continuous cropping are shifting the relative proportion of cropped area in much of Africa from the first and second categories to the third, where productivity and crop response to fertilizer are poor (Tittonell and Giller 2013).

Facile comparisons of average fertilizer application rates between Africa and other regions of the world (particularly East and South Asia) tend to be highly misleading. Policy discussions of low fertilizer use in Africa have tended to overemphasize failures in credit markets and underemphasize declining soil fertility associated with rising land pressures and continuous cultivation, poor soil management practices, and rainfed farming conditions in limiting African farmers' ability to use fertilizer profitably. This has led to the widespread but overly simplified view that low fertilizer use in Africa primarily reflects market access problems that can be overcome through input subsidy programs.

A potential consequence is that official fertilizer use recommendations are often based on unrealistic assumptions about smallholders' soil conditions and response rates (often derived from trials and experiments). In some African countries, official fertilizer use recommendations of the national extension systems are uniform throughout the country. For example, Zambia's Ministry of Agriculture advises the "4 by 4" strategy of four 50 kg bags of Compound D and four 50 kg bags of urea per hectare of maize, for a total application rate of 400 kg per hectare. Perhaps not surprisingly, less than 3 percent of Zambian smallholder farmers use fertilizer this intensively on their maize. Similarly, three studies investigating the profitability of fertilizer use in Kenya all found that official recommended use rates are far in excess of the economically optimal

level for most farmers (Duflo, Kremer, and Robinson 2008; Marenya and Barrett 2009; Sheahan, Black, and Jayne 2013).

The policy challenge of sustainably raising crop response to fertilizer is somewhat like turning a battleship: it is imminently feasible but will take considerable time. The profitability and effective demand for fertilizer in African agriculture in 2030 will depend on the extent to which African governments invest *today* in efforts to educate farmers about agronomic practices to rebuild soil organic matter and take advantage of crop rotations and intercrops capable of restoring soil responsiveness to fertilizer application. Unfortunately, public sector funding to crop science, agronomic management, and extension systems built on appropriate recommendations has remained chronically underprovisioned in many African countries, being much smaller than in any other region of the world. Public agricultural extension systems in many African countries are virtually defunct. In Zambia and Malawi, these expenditures currently account for less than 15 percent of total annual expenditures to agriculture. By contrast, input subsidy programs in these countries accounted for over 60 percent of public agricultural expenditures in recent years. Clearly, the foundation for increased fertilizer use in Sub-Saharan Africa will depend on a more systematic and integrative approach to sustainable agricultural intensification.

Evolution of Subsidy Programs in Africa

Given the weak evidence that increased fertilizer use would be financially or economically viable, how did ISPs become so widely used? Throughout the 1990s and until 2005, agricultural input subsidy programs had been largely phased out in Sub-Saharan Africa. The discontinuation of fertilizer subsidy programs occurred during this period of structural adjustment, aid conditionality, and strong international lender influence over agricultural policies.[10]

Starting in 2005 the landscape changed quickly and profoundly. Within several years after African governments had committed to raise their spending on agriculture under the 2003 Maputo Declaration, at least 10 countries had introduced or reintroduced fertilizer subsidy programs costing more than US$1 billion annually (table 3.2). Large-scale input subsidy programs became the centerpiece of many African governments' agricultural development programs. Five main factors drove this rapid sea change.

First, many African governments struggled to accept the tenets of structural adjustment and cut ISPs only under duress. Leaders had incentives for attempting to retain input subsidy programs. They were politically popular and often were part of the postindependence "social contracts" between leaders and their constituents to rectify earlier policies that discriminated against smallholder farmers.

Table 3.2 ISP and Broader Agricultural Sector Spending, 2011–14

		ISP cost (US$, millions)		Program fertilizer distributed (MT)	Program cost per MT of program fertilizer distributed (US$/MT) [B/C]	Public agricultural spending (US$, millions)	ISP cost as % share of public agricultural spending [=(B/E)*100]
		Official source	Computed using secondary data				
Country	Year		(B)	(C)	(D)	(E)	(F)
Universal subsidy							
Burkina Faso	2011	—	39	173	890	213	18.1
	2012	—	15	65	918	195	7.7
	2013	—	18	75	947	204	8.7
	2014	—	16	84	780	199	8.3
Ghana	2011	—	22	25	867	291	7.5
	2012	—	31	36	841	310	9.9
	2013	—	42	51	819	351	12.0
	2014	—	44	51	850	358	12.2
Mali	2011	122	112	176	634	419	26.6
	2012	123	114	176	646	364	31.2
	2013	—	143	262	545	391	36.5
	2014	—	166	268	619	378	43.9
Senegal	2011	—	42	54	785	182	23.3
	2012	—	33	41	785	374	8.7
	2013	—	27	36	764	368	7.4
	2014	—	32	43	736	390	8.2

(continued next page)

Table 3.2 (continued)

Country	Year	ISP cost (US$, millions)		Program fertilizer distributed (MT)	Program cost per MT of program fertilizer distributed (US$/MT) [B/C]	Public agricultural spending (US$, millions)	ISP cost as % share of public agricultural spending [=(B/E)*100]
		Official source	Computed using secondary data				
			(B)	(C)	(D)	(E)	(F)
Nigeria	2011	—	190	264	719	817	23.3
	2012	—	177	249	711	788	22.4
	2013	—	187	264	708	802	23.3
	2014	—	167	256	653	795	21.0
Targeted subsidy programs							
Kenya	2011	15	61	57	1072	356	17.2
	2012	—	61	68	894	386	15.7
	2013	—	72	81	896	444	16.3
	2014	—	89	112	796	479	18.6
Malawi	2011	127	179	149	1200	345	52.0
	2012	151	116	177	654	355	32.7
	2013	207	185	213	868	350	52.9
	2014	168	183	208	879	352	51.9
Tanzania	2011	94	134	110	1223	349	38.4
	2012	76	104	126	828	326	32.0
	2013	—	104	105	989	338	30.9
	2014	—	92	112	829	332	27.9

(continued next page)

Table 3.2 (continued)

Country	Year	ISP cost (US$, millions)		Program fertilizer distributed (MT)	Program cost per MT of program fertilizer distributed (US$/MT) [B/C]	Public agricultural spending (US$, millions)	ISP cost as % share of public agricultural spending [=(B/E)*100]
		Official source	Computed using secondary data				
			(B)	(C)	(D)	(E)	(F)
Zambia	2011	184	239	182	1010	613	30.1
	2012	166	164	184	902	325	50.6
	2013	113	173	188	601	376	45.9
	2014	—	180	208	865	407	44.2
Ethiopia's program (officially not a "subsidy")							
	2011	—	55	551	100	530	10.4
	2012	—	54	633	86	771	7.0
	2013	—	38	449	84	850	4.5
	2014	—	43	597	73	937	4.6

Sources: Official data are from government sources. Ghana: Ministry of Food and Agriculture, http://mofa.gov.gh; Malawi: NEPAD; Tanzania: World Bank appraisal of the Accelerated Food Security Program; Mali: Ricker-Gilbert et al. 2013; Malawi and Zambia: FAO, MAFAP database; Nigeria: Liverpool-Tasie and Takeshima 2015. Quantities of subsidized fertilizer are obtained from NEPAD for all countries except Ethiopia, Mali, Malawi, and Zambia. Other estimates are from Rashid et al. 2013.
Note: Computed costs are weighted average of commercial and fertilizer prices by amount of subsidized fertilizer in each country, and do not include administrative and other programmatic costs (such as import commissions). Prices for all countries except Ethiopia are obtained from the International Fertilizer Development Center. ISP = input subsidy program; — = not available.

Politically influential rural elites benefitted from input subsidy programs and lobbied forcefully for their reemergence when the environment for their reintroduction was more favorable (Bates 1987; van de Walle 2001). Hence, the seeds of strong local support for ISPs were most likely in the policy soil throughout the past several decades but were largely dormant during the structural adjustment period.

Starting around 2000, many African governments experienced a relaxation of the constraints on public budgets associated with the highly indebted poor countries (HIPC) debt forgiveness programs and a shift in international donor support to budget support. With the autonomy afforded governments by the relaxation of public budget constraints, the desire to reinstitute politically popular but expensive programs such as ISPs was revived.

A third factor encouraging the return to ISPs was the emergence of multiparty political systems in Africa starting in the early 2000s. Political parties often sought to outdo one another in terms of the support promised to constituents (Levy 2005), and ISPs were one of the promises that leaders often made (as in Malawi, Nigeria, and Zambia) to garner the rural vote.

The watershed event heralding the reemergence of ISPs in Africa was the "Malawi miracle." Initial but somewhat superficial assessments reported how Malawi's program had turned the country from a food basket case into a grain exporter and dramatically reduced rural poverty rates. While more recent analyses have shown the Malawi program's successes to be debatable in some respects and factually incorrect in others,[11] the Malawi case had an important "primacy effect" on policy discourse on the continent, convincing numerous governments to undertake similar targeted input subsidy programs. By 2010, at least nine other countries accounting for over 60 percent of Sub-Saharan Africa's population[12] had re-instituted input subsidy programs.

The term *smart subsidy* allowed politicians and supporters to argue that even though the prior track record of ISPs in Africa was quite dismal, it was possible to redesign the programs in ways that overcame prior political interference and implementation problems, and to learn from experience so as to increase the benefits of ISPs going forward. Morris et al. (2007) and the World Bank (2008) identified specific criteria for smart subsidy programs to guide African governments. The most important of these criteria were that they (a) promote the development of the private sector; (b) target farmers who were not using fertilizer but who could find it profitable to do so; (c) are one part of a wider strategy that includes complementary inputs and strengthening of markets; (d) promote competition and cost reductions by reducing barriers to entry; and (e) have a clear exit strategy. While these are clearly useful criteria to guide the design of subsidy programs, in hindsight few questions were raised as to how these criteria could be implemented in practice and whether sufficient change had been instituted on the ground to

justify expectations that well-known past implementation problems could now be overcome.

The final major factor contributing to the reemergence of ISPs in Africa was the global food price crisis in 2007 and 2008. During this time, panic over the availability of food supplies on world markets convinced many analysts and African leaders to support ISPs to promote national food self-sufficiency. And finally, in response to these concerns, the World Bank also started to support and even finance several countries' ISPs—including those of Ethiopia, Tanzania, Zambia, and Malawi—either directly or through budget support provided to ministries of finance.

Since 2010, other factors contributing to the staying power of ISPs have emerged. A recent study addresses a longstanding concern (only anecdotally addressed) that incumbent political parties are able to use ISPs to their benefit (such as to finance their political campaigns) by granting import licenses to particular fertilizer companies in exchange for receiving funds from overstating the cost of imports (Bigsten and Shimeles 2007).[13] Bigsten and Shimeles (2007) find an inverse correlation between government effectiveness and the gap between world fertilizer prices and retail prices in the country. The study suggests another important incentive that incumbent political parties may have to continue large-scale ISPs. Several institutional recipients of development assistance funds, while not officially supporting ISPs, have also promoted them by offering technical support to African governments in the design and implementation of ISPs.

Main Findings of Recent Research: What Is the Evidence on the Crucial Issues of ISPs?

Most of the divergent findings in the analysis of fertilizer subsidy programs are due to (a) differing assumptions about crop response rates to fertilizer use, (b) the contribution of subsidy programs to total fertilizer use after accounting for diversion of program fertilizer and crowding out of commercial fertilizer demand, and (c) the strength of multimarket effects on food prices and employment.[14] Fortunately, many studies have been carried out in recent years, and the weight of the evidence has coalesced around some particular findings on crucial questions that most can agree on. The annexes present a more granular and comprehensive discussion of lower-level issues summarized in box 3.3.

Significant Effects on Food Production

Large-scale input subsidy programs have tended to raise beneficiary households' crop yields and production levels, at least in the year that they receive the subsidy. However, the production effects of subsidy programs tend to be smaller than originally thought because of low crop yield responses to fertilizer on most

BOX 3.3

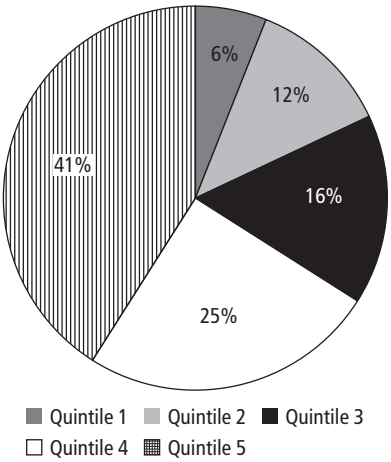
Summary of Evidence of Targeting and Impacts

Annex 3B has the full exposition of evidence of targeting and the impacts, which are summarized here.

Targeting

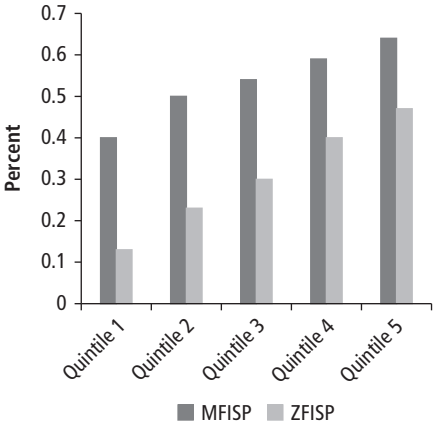
- *Targeting by gender of the household head.* Male- and female-headed households are equally likely to participate in ISPs and receive the same quantity of inputs on average. ISPs generally fail to meet the criterion of favoring female-headed households.
- *Targeting by landholding size.* Households with more land are more likely to receive program inputs or receive a larger quantity of such inputs on average. In Zambia, for instance, the lowest landholding quintile captured only 6 percent of the subsidies, while the highest quintile captured 40 percent (figure B3.3.1). While participation in ISPs is generally higher among households with more land, the extent to which this is the case varies considerably across countries (figure B3.3.2). Households with more land are often both more likely to receive inputs from the programs and receive larger quantities, on average, upon participating. This exacerbates crowding out of commercial input demand by the programs, reduces impacts on total fertilizer use (and hence incremental crop production), and attenuates poverty reduction effects.

Figure B3.3.1 Share of Subsidized Fertilizer Acquired in ZFISP by Landholding Quintile



Source: Jayne et al. 2016.
Note: ZFISP = Zambia Farmer Input Support Program.

Figure B3.3.2 Share of Households Particpating in MFISP and ZFISP by Landholding Quintile



Source: Jayne et al. 2016.
Note: MFISP = Malawi Farm Input Subsidy Program; ZFISP = Zambia Farmer Input Support Program.

(continued next page)

Box 3.3 (continued)

- *Targeting by assets, wealth, or poverty.* A higher level of farm assets is associated with receiving more ISP fertilizer and seed, but these estimated effects are not statistically significant after controlling for time-constant farmer characteristics. Differences in methodology and the definitions of assets, wealth, or poverty measures likely underlie many of the varying results.
- *Targeting and political factors.* The empirical record shows which groups of voters—core supporters of the incumbent party, swing voters, or core supporters of the opposition—are actually targeted. Overall, there is mounting empirical evidence of the politicization of ISPs in Sub-Saharan Africa, but the nature of the politicization varies across countries as well as within countries over time. The political economy of input subsidies is discussed in more detail in chapter 5 of this volume.
- *Targeting, social capital, and elite capture.* Social capital factors also lead to "elite capture" of ISP benefits. Where this issue has been investigated empirically, there is evidence that social capital factors influence access to subsidized inputs.

Household-Level Effects of ISPs

- *Fertilizer and improved seed use.* Although a few instances of crowding in exist, most ISPs crowd out commercial demand for subsidized inputs. That is, an additional ton of fertilizer (improved seed) distributed through input subsidy programs raises total fertilizer (improved seed) use, but by less than 1 ton. More recently, crowding out of commercial fertilizer sales may have been substantially underestimated due to fertilizer that has been diverted from subsidy program channels into what can be mistaken for commercial sales. Diverting program fertilizer has important distributional effects, with program implementers receiving a major portion of the program benefits rather than farmers. But there have yet to be any comprehensive studies of the extent to which ISPs encourage or deter private sector investment in input distribution.
- *Crop yields.* ISPs do raise maize yields. But crowding out and late delivery of ISP inputs are likely attenuating these effects, as are poor soil quality and the minimal use of complementary practices to raise crop yield response to fertilizer.
- *Crop production.* ISPs have had modest, positive, ceteris paribus effects on household-level maize production in all countries where this issue has been examined (Kenya, Malawi, and Zambia). In general, ISPs have modest, positive effects on maize production and on net crop income for some segments of the population. But the magnitudes of these effects vary at different points in the distribution of maize production.
- *Food security and nutrition.* Little research has been conducted on this topic.
- *Incomes, assets, and poverty.* ISPs have the potential to raise incomes and reduce poverty severity at the household level but are less likely to decrease the probability that households fall below the poverty line.[a]

(continued next page)

Box 3.3 (continued)

- *Soil fertility management practices, fallow land, and forests.* ISPs can alter incentives for various soil fertility and land management practices, but much remains to be learned about how ISPs affect the adoption of crops and inputs beyond those being promoted. To the extent that the ISPs encourage monocropping or otherwise "crowd out" good soil management practices—as some studies suggest—they exacerbate one of the fundamental causes of the low fertilizer use.
- *Dynamic or enduring effects of ISPs on farm households.* Depending on the outcome variable and context, ISPs may or may not have lasting positive effects on farm households beyond the year of receipt.

Market and General Equilibrium Effects

- *Aggregate fertilizer use.* Most ISPs partially crowd out demand for commercial fertilizer. However, a substantial share (roughly one third in Malawi and Zambia) of fertilizer intended for ISPs is diverted by program implementers before reaching intended beneficiaries and resold as commercial fertilizer at or near commercial prices. Although ISPs raise total fertilizer use, there are major inefficiencies and diversions by program implementers, representing another form of elite capture of ISP benefits.
- *Aggregate crop production and food self-sufficiency.* The only studies that directly estimate these effects have been conducted for Malawi and take either a partial equilibrium or computable general equilibrium (CGE) modeling approach. They suggest increases in national maize production as a result of the Malawi Farm Input Subsidy Program (MFISP) of 9–23 percent (with even larger percentage increases among targeted households) and increases in net maize exports of 132–188 percent.
- *Food prices.* In general, ISPs reduce food prices—but by substantively small magnitudes.
- *Agricultural labor wage rates and supply/demand.* ISPs could further benefit poor nonbeneficiary households, which often engage in agricultural wage labor, if the programs increase demand for such labor and therefore put upward pressure on agricultural wages.
- *Incomes and poverty.* ISPs could reduce the national poverty rate and, more specifically, notoriously stubborn rural poverty rates. That said, there is little empirical evidence to examine these relationships.
- *Voting patterns and election results.* The conventional wisdom is that scaling back of ISPs is politically damaging, whereas establishing or scaling up ISPs is politically beneficial. But does the empirical record support these claims? The answer depends on the context, both in the political dynamics and in the design and implementation of the ISP.

a. See Awotide et al. (2013) and Carter, Laajaj, and Yang (2014) for randomized controlled trial (RCT) estimates of income and poverty eff ects of a certifi ed rice seed voucher pilot program in Nigeria and the income effects of a government ISP pilot program in Mozambique, respectively. Unlike the studies for Kenya and Zambia, Awotide et al. (2013) find that participation in the seed voucher pilot program in Nigeria does reduce the probability of household income falling below the poverty line.

smallholder-managed fields and because of the tendency of subsidy programs to partially crowd out commercial fertilizer demand. Therefore, the national production response to subsidy programs, while significant, has typically been lower than expected.

Fertilizer Use Inhibited by Diversion and "Crowding Out"

Recent subsidy programs, even those asserted to conform to smart subsidy criteria, have remained vulnerable to diversion and crowding out of commercial fertilizer demand. Subsidy programs often distribute fertilizer to beneficiaries who consistently purchased commercial fertilizer in the past, which can result in fewer purchases from commercial sources after being given several bags of subsidized or free fertilizer. The magnitude of "crowding out" of commercial fertilizer depends primarily on the characteristics of targeted beneficiary farmers. Crowding out tends to be smallest when beneficiaries have not purchased commercial fertilizer in the past and in areas where commercial fertilizer sales are low or nonexistent. Under such conditions, crowding in of commercial fertilizer purchases may even occur.

Crop Response Rates of Smallholder Farmers Are Highly Variable and Usually Low

Production impacts of fertilizer subsidy programs tend to be lower than previously envisaged because a large proportion of smallholder farmers do not use fertilizer efficiently. Smallholder farmers tend to obtain marginal and average products of fertilizer that are substantially lower than those obtained from studies of researcher-managed trials and experiment stations. Well-designed extension and service delivery programs could enable farmers to use complementary inputs and management practices that raise their crop response rates to fertilizer application, raising the benefit-cost ratio of ISPs.

Fertilizer Use in Much of Africa Is Low by International Standards but Not Necessarily Suboptimal

Because of the low efficiency of fertilizer use on the majority of smallholder farms—and based on prevailing input-output price ratios, which have stayed remarkably constant over the past several decades—fertilizer use does not appear to be clearly profitable for many farmers, especially in the semiarid areas with variable rainfall. While Africa is often compared unfavorably with Asia in terms of fertilizer use, high intensity of fertilizer use in areas experiencing their Green Revolutions were confined largely to irrigated areas or areas with significant potential for water control and where the risks of fertilizer use were relatively low but expected returns tended to be higher (Gautam 2015). Areas of dryland Asia also tend to have relatively low fertilizer use rates

and application rates comparable to many drought-prone areas of Africa (Jayne and Rashid 2013).

Relatively Small and Transitory Effects on the Incomes of Beneficiary Households

Recipient households tend to significantly increase their net farm incomes in the year in which they receive subsidized fertilizer, because they pay only a fraction of the cost of the fertilizer and because of the additional output obtained from the fertilizer. However, the lack of persistent yield response and crowding out are directly linked to the relatively small transitory effects of ISP participation on incomes and poverty.

No Major Effect on Food Prices or Wage Rates

Fertilizer subsidy programs have either insignificant or modest but significant impacts on national maize prices. The factors explaining small food price effects vary by country. Sometimes, the production effect of subsidy programs can be quite large in a few years of the program, as in Malawi, but not large enough to totally displace national cereal imports, such that most of the country remains at import parity price levels both before and during the subsidy program period (Ricker-Gilbert et al. 2013). In other cases, the production effects of subsidy programs are not large enough to even have major effects on local food markets or rural wage rates.

ISPs Produce Beneficiaries Who Lobby Forcefully for the Continuation of Programs Once Initiated

Evidence from countries where the distribution of subsidies has been documented indicates that most benefits go to farmers who are higher-income or larger landholders (see box 3.2 and table 3.3). There is also mounting statistical evidence that the geographic distribution of fertilizer subsidies reflects the influence of political and election-related motives.

Limited Evidence That Fertilizer Subsidy Programs Kick-Start Dynamic Growth Processes

While only a few studies exist on the potential enduring effects of fertilizer subsidy programs, the evidence is mixed. Carter, Laajaj, and Yang (2014) find enduring production and income impacts for Mozambican farmers receiving a subsidy two years in a row, but the impacts seem to decay after two years. Another study shows little impact on fertilizer use or crop production even one year after Malawi farmers graduated from the subsidy program following three years of participation (Ricker-Gilbert and Jayne 2015). This question of whether

Table 3.3 Benefits Are Low in Relation to Costs—and Go to Richer Farmers

Country	Characteristics of recipient households acquiring subsidized fertilizer	Financial benefit-cost ratio	Economic benefit-cost ratio
Malawi	Households with larger landholding and asset wealth get more	0.62	0.80
Zambia	Households with more land get slightly more	0.56	0.92
Tanzania	Voucher recipients more likely to be nonpoor	n.a.	n.a.
Kenya	Households with higher landholding receive more subsidized fertilizer	0.79	1.09
Ghana	Asset wealth greater among beneficiaries than among nonbeneficiaries	n.a.	n.a.
Nigeria	Increase in landholding raises subsidized fertilizer received	n.a.	n.a.

Sources: Chirwa and Dorward 2013; Jayne et al. 2015.
Note: The table presents summary evidence from farm and household studies on impacts. Ratios are estimated based on five-year estimated response rates. The ratios reported here use baseline calculations, making adjustments to average partial effect of 1 kg of subsidized fertilizer on total smallholder fertilizer use.
n.a. = not applicable.

fertilizer subsidies can generate dynamic growth processes that put recipient farmers on a higher long-term income trajectory is an area in which more research is needed.

Implications for the Design and Implementation of Smarter Subsidy Programs

Smart subsidy programs could be more than a slogan. The scope for improving subsidy program impacts could be substantial in the following areas. Assuming that African governments will continue to run ISPs for some time to come, evidence indicates that these programs can more effectively achieve their goals in the following ways:

- Target the subsidies to households that could use fertilizer profitably but could not afford to do so (or whose purchases are well below optimal levels) due to credit constraints.
- Involve the private sector to a greater degree than is currently done in most cases, as through the use of vouchers that are redeemable at any private retail store.
- Confront and tackle the problem of diversion of subsidy program fertilizer by authorities.

Target Recipients More Effectively

Appropriate target criteria are difficult to define because they depend on program objectives, which tend to be variously articulated in Africa. Many African governments state their ISP objectives in vague and inconsistent terms, making it difficult to identify the extent to which beneficiaries conform to targeting criteria. Ex post assessments show that recipients of vouchers and fertilizers were generally "better off" initially than nonrecipients in terms of farm sizes, asset wealth, and political or social connections, suggesting that ISPs tend to be disproportionately targeted to, or captured by, the better-off members of rural communities. Relatedly, recipients also tend to have already been using fertilizer in prior years compared to nonrecipients, at least partially because they are able to afford it. Targeting areas where fertilizer use is low and yield response potential is sufficiently high (that is, where use is hindered primarily by credit constraints) will more likely contribute to increased fertilizer use and increased production and productivity. Programs that do not exclude households already purchasing commercial fertilizer or that operate in areas where commercial fertilizer use is already high tend to have a diminished positive impact.

Targeted Versus Untargeted Universal Subsidy Programs?

Decentralized targeting systems have been considered attractive because they reduce the costs of targeting effectively by tapping into local knowledge. However, local political systems have their own political economy challenges, and it is not clear that programs relying on village-level targeting outcomes necessarily improve the distribution of recipients compared to universal subsidy programs through the market or what random allocations of vouchers would have yielded (Pan and Christiaensen 2012). Since many, if not most, studies assessing ISP targeting show regressive targeting *in practice,* it might be asked whether the benefits of ISPs based on targeting (as opposed to nontargeted allocations such as the universal subsidy programs, as in much of Asia) outweigh the significant costs involved in the process of determining recipients.

But universal subsidy programs also have major disadvantages. Past experiences across the world indicate that larger farmers disproportionately benefit from universal subsidies. And it is questionable whether many governments would find a truly universal, unrationed fertilizer subsidy program financially feasible (or desirable given the high opportunity cost and the probability that some portion of the fertilizer would end up in other countries).

Minimizing "Crowding Out"

As noted in the section dealing with targeting, subsidies generally fail to effectively target poor farmers and farmers who are not already using fertilizer.

As a consequence, empirical analyses show significant displacement of commercial channels of distribution. To minimize the potential for "crowding out" of commercial fertilizer demand, one suggestion would be to avoid areas where the private sector is already highly active. Of course, this would imply focusing on areas of low private sector activity, but one must then consider *why* the private sector has not been active. If the reason is that low response rates render fertilizer use unprofitable at commercial prices, fertilizer subsidies are not a viable tool (at least in the long run) for reducing poverty or increasing production. In such a case, one of the alternative strategies discussed later (investments in technological development and extension) is probably more appropriate. If, by contrast, a high transfer cost is the factor driving down profitability, again, fertilizer subsidies are at best a short-term solution to a long-term problem, and again, an alternative strategy (investments to lower transfer costs) will probably be more effective.

Alternatively, a subsidy program could aim to employ the private sector distribution network, rather than supplant it. The most promising option using this approach is voucher-based ISPs, but this strategy has potential drawbacks as well. First, most pilot voucher programs also remain vulnerable to the problem of diversion (of vouchers instead of bags of fertilizer). Second, relying on the private sector *does* accompany the risk of leaving behind those underserved by the private sector for whatever reason. This brings us back to the question of *why* the private sector is not active in some places, and whether input subsidies are the best (or at least not the only important) strategy for long-term productivity growth.

Transparency of ISP Costs and Diversion

Many ISPs in Africa seem to suffer from underreporting or hidden program costs. Some governments do not publish the fiscal costs of their ISPs. Others report the budgeted costs but not actual ex post expenditures, which are found to be substantially higher (Mason and Jayne 2013). On top of this is the related problem of potential diversion of public resources associated with fertilizer subsidy programs. Widespread anecdotal reports suggest that governments and fertilizer import companies may collude to overinvoice the cost of delivering fertilizer to designated supply points. Shimeles, Gurara, and Tessema (2015) examine the fertilizer retail-import price gap in 14 African countries between 2002 and 2013. The price differentials between the retail fertilizer price and the world market price are negatively correlated with measures of government effectiveness, suggesting that in environments with poor governance, these programs may be susceptible to this kind of overinvoicing and corruption. In such cases, costs to the treasury and farmer prices could both be driven up. Increased transparency regarding the program costs could go a long way toward reducing the risk of this problem.

Absence of Complementary Public Sector Actions Reduces The Effectiveness of ISPs

In responding to incentives, farmers are likely to demand more fertilizer if obtaining a higher crop response to fertilizer enables them to use it more profitably. Doing so will require that farmers obtain higher response rates to fertilizer application, which will in turn require greater public investment in effective systems of agricultural research, development, and extension that emphasize bidirectional learning between farmers of varying resource constraints and agroecologies, extension workers, and researchers.

Variations in crop response to fertilizer application are primarily due to variation in soil quality and farmer management practices that affect soil quality and yield. Examples include timeliness of planting, row spacing, seed spacing, intercropping and crop rotations, water control, sufficient weeding, plot drainage, terracing in hilly terrains, and adoption of conservation farming practices such as planting basins, ripping, and mulching. Many of these practices and technologies are promising in some agroecologies and not in others. Some may also not be feasible for resource-constrained farmers, and must be adapted through bidirectional learning between farmers and researchers to fit the conditions of different types of farmers.

There is currently a lack of specific information on the profitability of the different soil-crop-fertilizer combinations that could be employed in most countries' diverse agroecologies and soil types. The lack of location-specific information on crop-fertilizer profitability and the various farmer management factors that can favorably influence response rates means that researchers and extension agents are not in an informed position to provide guidance to farmers about "best practices." Suboptimal farmer practices for soil fertility management increase yield risk, impede farmers' incentives to use fertilizer, and result in forgone agricultural output. Knowledge of soil characteristics and processes regulating nutrient availability is essential to raise productivity per unit of fertilizer.

Try a Program of Soil Fertility Management

Therefore, the contribution of ISPs—and fertilizer use in general, even in the absence of ISPs—to sustainable growth could be much greater if the soil-related constraints on agricultural productivity were addressed through a broad program of soil fertility management. The general elements of such a program are as follows:

- *Public sector research and development programs* to identify region-specific best practices for amending soil conditions, given the great microvariability in agroecological conditions in each country.

- *Public agricultural extension programs* to disseminate improved technologies and cultivation practices, as well as provide learning opportunities between researchers and farmers to refine practices in light of farmers' experiences in their fields.
- *Input distribution systems* that make available a full range of products and services required by farmers. Input distribution systems for a wider set of soil-enhancing products, such as organic fertilizer, lime, and new lines of inorganic fertilizer (such as deep-placement, slow-release types), will be developed once there is proven effective demand for such products. The point is that commercial input distribution systems do not develop spontaneously; instead, they require public investments to generate effective demand among farmers for new inputs.
- *Ancillary public support services,* such as investments in port, rail, and road infrastructure to reduce costs of delivering fertilizer to rural areas and goods to markets; rural electrification;[15] and small-scale irrigation schemes.

To move from general thrusts to concrete steps, consider the following proposals:

- *Step 1. Provide support to existing research institutions* in countries' diverse agroecologies and regions to develop best practices for crop and soil management in different landscape conditions. Site-specific recommendations on practices require a better understanding of the factors that might constrain productivity. Soil maps need to be updated to reflect soil functional properties (rather than soil taxonomic class) as well as more spatial detail on the variation of these functional soil properties. Affordable techniques are available for wide-scale soil testing and analyses. Building the capacity to conduct soil testing services in rural Africa would provide an important foundation to provide farmers with improved knowledge on how to manage soils and improve returns from farming.
- *Step 2. Conduct extensive testing of the recommended soil management practices* on farmers' fields to allow local research institutes to determine crop response to the various inputs. This would support the formulation of recommended input packages to raise farmers' expected returns to investment. Use of locally available (organic) resources could be considered as part of the solution. This will involve collecting, collating, and analyzing existing secondary and primary data and using appropriate crop and soil fertility models.[16] Local extension services could provide soil management recommendations—such as implementing nutrient management options with other soil amendments for the crops, and using improved varieties, aiming to improve the agronomic efficiencies of the fertilizer use—that would in turn raise demand for fertilizer.

- *Step 3. Conduct monitoring and evaluation of yields* on the fields of farmers who have adopted the recommended practice, allowing for gradual development toward a "best fit" solution that reflects the farmer's socioeconomic situation. Improved information and communications technology (ICT) tools can be used for data collection and enhance collaboration with the research community.
- *Step 4. Implement fertilizer quality regulations to protect farmers.* Ongoing efforts to identify how to reduce potential problems associated with fertilizer quality and product adulteration should be encouraged. For example, West African governments could identify areas that need strengthening in terms of their capacity to adapt the regional regulatory framework signed by the Economic Community of West African States (ECOWAS) in 2012. This will help ensure that farmers access good quality fertilizers with correctly specified nutrient content having implications for crop response rates.
- *Step 5. Review policies affecting fertilizer use and response rates.* Specific government policies may have unintended adverse consequences on governments' efforts to promote fertilizer use. In some countries, fertilizer-importing companies pay multiple fees from different regulatory bodies involved in fertilizer control at the clearing stage. In Tanzania, for example, this includes the Tanzania Fertilizer Regulatory Authority (TFRA), the Weight and Measures Authority, the Radiation Commission and Chief Government Chemist, and the Tanzania Bureau of Standards. As a result, there are multiple fees, which are inevitably passed to farmers through higher prices.

Other Complementary Measures Are Also Needed

Beyond all these measures to address the soil fertility and crop response rates, perhaps even more important is for the public sector to use policies and investments to make fertilizer use more profitable for farmers and thereby raise effective commercial demand. This would involve identifying how to streamline costs and reduce risks in fertilizer supply chains to lower the price of fertilizer at the farmgate (Jayne et al. 2003). It would also involve supporting reliable and competitive output markets through policies that promote new investment and competition in agri-food value chains (World Bank 2007). And it would involve using research, extension, and education services to promote farmer training and education programs to improve fertilizer efficiency in the context of a more comprehensive soil fertility management program (Dreschel et al. 2001; Tittonell and Giller 2013). Much of the investment comes from the private sector, but public policy can play an important role by removing regulatory barriers and making appropriate investments.

Annex 3A: Overviews of Specific Input Subsidy Programs in Africa

This annex provides brief overviews of the major government ISPs in Sub-Saharan Africa: Ethiopia, Ghana, Kenya, Malawi, Nigeria, Tanzania, and Zambia. We focus on these countries because each has been the subject of multiple econometric- or simulation-based studies of de facto program targeting or impacts—results that are synthesized in the next section. There are several other government ISPs in Sub-Saharan Africa, including in Burkina Faso, Burundi, Mali, Rwanda, and Senegal. These programs are not covered here because there have been few, if any, analyses of the programs' targeting or impacts.[17] These are major knowledge gaps in need of future research.

We begin with Malawi, which in 1998 was the first country to explicitly implement a major fertilizer subsidy program after the structural adjustment period of the 1980s to mid-1990s.[18] Malawi continues to garner the most attention of all countries implementing ISPs, most likely due to the media attention that it garnered after a front-page New York Times article in 2007 (Dugger 2007). Nigeria began subsidizing fertilizer in 1999 and Zambia established its new Fertilizer Support Program in 2002. After pledges were made at the 2006 Africa Fertilizer Summit, Kenya joined the field in 2007, followed soon after by Ghana, Ethiopia, and Tanzania in 2008 (Druilhe and Barreiro-Hurlé 2012; Jayne and Rashid 2013).[19]

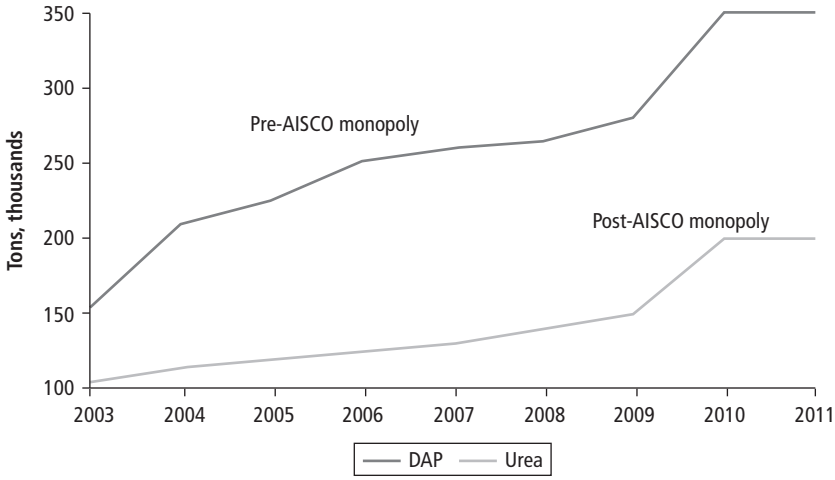
Ethiopia

Prior to the 1990s the main social safety net in Ethiopia was international food aid. But food aid was understood to be a weak development strategy that had little or no impact on the underlying causes of Ethiopia's poorly functioning food markets, including high transfer costs associated with a lack of market information, infrastructural investment, and storage capacity (Minten, Stifel, and Tamru 2014). Since the 1990s (and earlier under central planning), fertilizer in Ethiopia has been distributed almost exclusively by government agencies. Early on, this was the Agricultural Input Supplies Corporation (AISCO), later called the Agricultural Input Supplies Enterprise (AISE). AISE-led marketing was generally considered inefficient, however, so in 1992 the New Marketing System (NMS) was an effort to introduce the private sector (Rashid et al. 2013). Private companies were slower to respond than policy makers expected and by the late 1990s just four fertilizer companies were active market participants. The next evolution was the growth of companies owned by regional governments and supplying to AISE, and by the early 2000s nongovernment imports had reduced to zero (Rashid et al. 2013). In the mid-2000s farmer organizations

became more involved with distribution and allocation. By 2008 roughly 75 percent of all fertilizer used moved through this market. The system was rife with inefficiencies, though, and in recent years government holding companies have been crowded out of the market. All imports come directly through AISE and what is now called the Growth and Transformation Program (GTP) (Rashid et al. 2013).

The amount of fertilizer to be distributed each year is determined through a consultative process between development agents (extension workers) and policy makers at GTP based on planned planting and centrally decided production targets. During the 2000s, fertilizer use increased dramatically, having been applied to 24 percent of all cereal crops in 2011, up from 16 percent in 2004 (Rashid et al. 2013). Total fertilizer use has similarly increased during that time. Throughout the 1970s, for example, fertilizer use was essentially nil, but 550,000 tons were applied in 2010 and 2011 (the most recent data available, figure 3A.1). In addition to subsidizing prices, much of the Ethiopian efforts attempted to address cost buildups in the value chain related to, for example, an inadequate road system. Planned openings of two major breweries were expected to increase fertilizer demand (Rashid et al. 2013), but delays resulted in official openings being pushed to January 2015. It is not possible to know if this has indeed driven input demand.[20] In a country of more than 100 million, it is unlikely that these relatively fortunate smallholders will have much effect at the national level.

Figure 3A.1 **Fertilizer Use in Ethiopia, 2003–12**



Source: Jayne et al. 2016.
Note: AISCO = Agricultural Input Supplies Corporation; DAP = diammonium phosphate.

The direct costs of running Ethiopia's subsidy plan average roughly US$40 million. But there are frequent miscalculations made on how much is imported by the government each year. Rashid et al. (2013) reckon the carryover and loss costs have added an additional US$30 million in recent years.

A second Ethiopian safety net program (which is not officially a subsidy, though public sector agencies are involved in input handling and distribution) comes under the umbrella program called the Ethiopia Food Security Program (EFSP). The first component of the EFSP is the Productive Safety Net Program (PSNP), also designed to replace food aid as the main social safety net. The PSNP provides direct support in the form of work-for-food or work-for-pay on public work projects, thus simultaneously addressing social welfare and preexisting market constraints (for example, infrastructure building). Work activities are usually planned to occur from January to June to avoid conflicting with the agricultural season (Hoddinott et al. 2012; Rashid et al. 2013). Some recipients (about 15 percent) receive direct cash transfers if they are deemed very poor, but unable to supply labor (Gilligan, Hoddinott, and Taffesse 2009; Rashid et al. 2013). Work-for-food recipients receive 3 kg of cereal per day. Cash transfers were initially Br 6 per day, which increased with inflation to Br 8 per day in 2008 and Br 10 (roughly US$0.75 per day) in 2010 (Hoddinott et al. 2012).

The second component of the EFSP was first named the Other Food Security Program (OFSP), then revised and renamed the Household Asset Building Program (collectively OFSP/HABP) in 2009. OFSP/HABP activities are meant to include access to regular outreach from extension agents on soil and water conservation, irrigation, and even beekeeping, as well as access to other "modern inputs" including fertilizer and improved seed varieties (Gilligan, Hoddinott, and Taffesse 2009; Hoddinott et al. 2012). While the PSNP was designed as a social safety net, the OFSP/HABP is intended to aid in the growth of smallholders' asset wealth and decrease or eliminate household dependence on government assistance. Early challenges were faced due to a lack of extension agents (Hoddinott et al. 2012). Therefore, after the 2009 reforms, each *kebele* (a subdivision of *woredas*, or wards) receiving assistance was assigned three resident development agents specializing in crops, livestock, and natural resource management. Anecdotal evidence from farmer interviews suggests this has improved the situation, but it is also noted that the primary assistance remains highly focused on crops. Partly due to EFSP activities, it has also been noted that the current level of infrastructure development is unprecedented (Minten, Stifel, and Tamru 2014). This too has theoretically improved access to fertilizers, but these effects, to our knowledge, have not been rigorously quantified. That said, Rashid et al. (2013) have noted that the fertilizer value chain in Ethiopia is competitive relative to its neighbors, with fertilizer prices 12–35 percent lower than in neighboring Kenya, Uganda, Rwanda, and Tanzania.

Targeting for the EFSP is done at the administrative level. Initially, 282 woredas considered rural, poor, and food insecure were targeted. The PSNP is said to have delivered support to more than 7 million Ethiopians in 2007, for example (Hoddinott et al. 2012). That said, the definition of the term *poor* and indeed the household targeting criteria have been criticized as unclear, and the characteristics of recipients (gender, wealth, political affiliation, and so on) varies widely across woredas (Rashid et al. 2013).

Ghana

Ghana's history of subsidizing inputs dates back to the 1970s, where, like many other countries, early versions were characterized by government monopolies for importation and distribution. The fertilizer subsidy rate peaked at 65 percent in the early 1980s. Recognizing that the early program was fiscally unsound and detrimental to Ghana's macroeconomy, and with urging from the World Bank and other donors, the parastatal-led subsidies were phased out during the late 1980s and removed altogether by 1990 (Jebuni and Seini 1992; Resnick and Mather 2015). Thereafter the entire fertilizer supply chain has been managed by the private sector (Resnick and Mather 2015).[21]

Fertilizer subsidies for the country's main cash crop, cocoa, were reintroduced in 2003 and for food crops in 2008. The latter was called the Ghana Fertilizer Subsidy Program (GFSP), and still is, though in 2012 the program expanded to include seed inputs for maize, rice, and soybeans (Resnick and Mather 2015). The GFSP was intended as a temporary program but it has become a perennial (and seemingly permanent) part of Ghana's agricultural budget. The reinvigorated subsidy program came about for several reasons, including encouragement from the private sector, fertilizer and food price increases, political popularity and imminent elections in 2008, and the perception that Ghana faced challenging soil infertility problems and below-average fertilizer use (even among African nations) (Banful 2009; Resnick and Mather 2015).

Unlike Ghana's earlier programs and contemporary programs in other countries, the GFSP was heavily reliant on the private sector. Initially, the government's role was limited to allocating benefits to targeted farmers using paper vouchers. According to several structured interviews summarized by Resnick and Mather (2015), the heavy role for the private sector was motivated by the government's desire to maintain its reputation as business-friendly. Furthermore, donors (including the World Bank) had recently increased funding for Ghana's agricultural budget and strongly advocated for private sector inclusion.

In 2010 still more responsibility was shifted to the private sector as vouchers were abandoned in favor of a "waybill" design. This required approved farmers to acquire subsidized fertilizer from registered agents. GFSP agents were

then to submit receipts to government for approval, shifting the bulk of administrative responsibility to the private sector. This revision also loosened constraints on the time of extension agents, many of whom complained that issuing and monitoring vouchers hindered their ability to carry out their intended duties (Resnick and Mather 2015).

In the seven years since the program's beginning, motivation for the GFSP has frequently shifted from increasing productivity as an urgent response to price spikes to providing a social safety net for the poor, to demonstrating the benefits of fertilizer to farmers (Resnick and Mather 2015). Correspondingly, the intended group of beneficiaries has been a moving target. Under the initial voucher system only smallholder food crop producers were intended to receive the subsidy. Banful (2009) and others, however, found that this criteria was often implemented poorly—substantial quantities were being distributed to larger farms or smuggled out of the country and resold. Yawson et al. (2010) also report overwhelming dissatisfaction with the timing of fertilizer availability during the period of the voucher system. In 2010, with the shift to waybill-based distribution, targets were essentially abandoned and, while the total quantity subsidized fertilizer was limited, food crop producers of any size were eligible to receive subsidized prices. In 2013, the target shifted back to smallholders, but with geographic and crop priority going to maize, rice, sorghum, and millet farmers in the savannah. Outgrower schemes and female farmers were also given priority (Resnick and Mather 2015).

Despite (or perhaps because of) many attempts to revise the GFSP, the program has faced considerable criticism. This includes a lack of transparency, poor monitoring and evaluation, delayed payments to suppliers, the aforementioned shifting and sometimes unclear objectives, and regular uncertainty on GFSP's design and rollout. In some years GFSP details have not been announced until very near the beginning of the planting season (Resnick and Mather 2015). Partly for these reasons, but most important because the government lacked funding to pay importers, the GFSP was suspended for the 2014 season. The program was renewed in 2015, but in light of past frustrations at least two of the country's major private importers declined participation (Resnick and Mather 2015). Notably, these are the same companies that advocated for instituting the GFSP less than a decade earlier.

The program supplies four types of fertilizer: NPK (15:15:15), NPK (23:10:05), urea (46:0:0), and ammonium sulfate (21:0:0, plus 24 percent sulfur) (Yawson et al. 2010). The goal during the first two years of the program was to keep subsidized prices consistently at 50 percent of the market price (Yawson et al. 2010). By best estimates, initial subsidies were 30 percent of the fertilizer's market value on average (Wanzala-Mlobela, Fuentes, and Mkumbwa 2013). This steadily increased until 2012 when the peak subsidy rate was 47 percent on average, then declined to 26 percent

and 21 percent in 2013 and 2015, respectively. Similarly, the quantity of subsidized fertilizer has climbed steadily from the initial level of 43,000 MT to roughly 170,000 MT on average from 2011 to 2013. After the 2014 hiatus, announced plans were to distribute 180,000 MT in 2015. GFSP share of Ghana's agricultural budget naturally followed suit, increasing from 20 percent to more than 50 percent between 2008 and 2012. When the subsidy rate declined in 2013, the GFSP share of the agricultural budget decreased back to roughly 20 percent, where it is expected to remain in 2015.

In 2008 the government budgeted about US$11 million to the GFSP, but exceeded this target by more than US$3 million. The following year more than US$26 million was allocated and was expected to absorb the program's debt from the previous year. Total spending on the GFSP in 2015 (for fertilizer and seed) is expected to be roughly equivalent to US$23.5 million, which is less than 70 percent of peak spending in 2013 (Resnick and Mather 2015, and government documents referenced therein; Wanzala-Mlobela, Fuentes, and Mkumbwa 2013).

On the effectiveness of fertilizer use, survey data collected in 2012 in various Ghanaian production zones do show noteworthy differences in yield, particularly when fertilizer use is coupled with hybrid seed planting (table 3A.1; Ragassa, Chapoto, and Kolavalli 2014). On average, local maize seed varieties on fertilized fields are about 70 percent more productive than when fertilizer is *not* used. Moreover, fertilized fields planted with hybrid seeds are an additional 60 percent more productive per unit of land than fertilized fields using local varieties. Altogether, based on these data, fields with fertilized hybrid maize seeds are about 175 percent more productive than unfertilized fields using local seed (at least in terms of per unit of land). Some important caveats to these results are that these average comparisons mask a wide variety in the differences in fertilizer use efficiency across regions (and almost certainly across farms within regions); these results are naïve and potentially subject to some of the biases we've outlined and even the most productive group found in these results (hybrid seed and fertilizer using farmers in the Sudanese Sahel) are obtaining yields (about 2.4 MT per ha) that would be considered low by most standards.

Table 3A.1 Maize Yields by Farming Systems in Ghana, 2012

Maize system	Transition	Guinea savannah	Sudan savannah
Local, no fertilizer	756	745	547
Fertilized local	1,208	914	1,339
Fertilized hybrid	1,819	1,444	2,374

Source: Adapted from Ragassa, Chapoto, and Kolavalli 2014.

Kenya

Kenya has had two major ISPs since structural adjustment—the National Accelerated Agricultural Inputs Access Program (NAAIAP), which is targeted, and the National Cereals and Produce Board (NCPB), which is universal. We describe each of these.

National Accelerated Agricultural Inputs Access Program, 2007/08–2013/14

The Kenyan government initiated NAAIAP in the 2007/08 agricultural year, shortly after the 2006 Africa Fertilizer Summit and in the midst of the 2007–08 food, fuel, and fertilizer price crisis. The program ran through 2013/14, after which county-level governments assumed responsibility for ISPs in Kenya. NAAIAP's main goal was "to improve farm input (fertilizer and seeds) access and affordability of smallholder farmers to enhance food security/availability at the household level and generate income from the sale of surplus produce" (KMOA 2007, 7). Additional objectives included raising smallholders' productivity and production, and reducing poverty (KMOA 2007). The ISP portion of NAAIAP, called Kilimo Plus, provided targeted beneficiaries with a voucher redeemable at accredited agro-dealers' shops for 100 kg of fertilizer (50 kg each of basal and top dressing) and 10 kg of improved maize seed.[22] The inputs were fully subsidized; no farmer top-up payment or contribution was required.

The NAAIAP aimed to target "resource-poor" farmers who were unable to afford inputs at market prices, who grew maize, had 1–2.5 acres of land, and who were "vulnerable members of society," with female-headed households given priority (KMOA 2007, 19). Beneficiaries were selected by stakeholder forums, which included farmers, other community members, and representatives from the Ministry of Agriculture, Livestock, and Fisheries (KMOA 2007). The NAAIAP was not implemented in all districts; rather, districts were selected based on their suitability for maize production and poverty level. Over the life of the program, NAAIAP was implemented in 149 districts (of more than 200 districts in Kenya at the time) (KMOA 2013). The scale of NAAIAP varied over time, and the program peaked in 2009/10 at 176,000 intended beneficiaries or about 5 percent of Kenyan smallholder households. See table 3A.2 for a summary of the number of beneficiaries and approximate voucher values from 2007/08 through 2011/12.[23]

National Cereals and Produce Board Fertilizer Subsidy Program, 2001–Present

The National Cereals and Produce Board (NCPB) is a crop marketing board that has existed since the colonial era; since 2001, it has also distributed subsidized fertilizer to Kenyan farmers. During the program's first seven years, the quantities distributed were small (averaging just 7,625 MT per year). In 2008/09

the program was scaled up dramatically to 52,608 MT (see table 3A.3). The Kenyan government justified this increase, as well as the establishment of NAAIAP, as temporary responses to the 2007–08 price crisis as well as to the post-2007 election violence and associated poor harvest (Ariga and Jayne 2011; Mather and Jayne 2015). According to the NCPB, its vision for the subsidy program is to "take … inputs closer to the farmer," "provide [a] one-stop point for the farmer's needs," "to supply the farmer with the right quality at the right time and at competitive prices," and to enable the farmer to buy inputs at the same time that s/he sells maize to the NCPB to cut down on transport and transactions costs (NCPB 2013, 6).

NCPB subsidized fertilizer is sold at panterritorial prices at NCPB depots throughout the country. The program is universal in that (in theory) any farmer can access it. The quantity available to a given farmer is determined roughly based on farm size. Subsidy rates have varied but are typically in the range of 30 percent (Jayne et al. 2013).

Table 3A.2 Key Features of the Kenya National Accelerated Agricultural Inputs Access Program, 2007/08–2011/12

	2007/08	2008/09	2009/10	2010/11	2011/12	Total
Total number of beneficiaries	36,000	92,876	175,973	125,883	63,737	494,469
Number of districts covered	40	70	131	95	63	149
Voucher value (US$)	103.67	93.95	76.03	81.25	95.69	—

Source: KMOA 2013.
Note: — = not available.

Table 3A.3 Quantities of Subsidized Fertilizer Distributed through Kenya's National Cereals and Produce Board, 2001/02–2011/12

Year	MT of subsidized fertilizer distributed
2001/02	1,403
2002/03	2,207
2003/04	6,827
2004/05	11,131
2005/06	6,167
2006/07	16,137
2007/08	9,506
2008/09	52,608
2009/10	8,388
2010/11	45,264
2011/12	82,023

Source: NCPB 2013.
Note: More recent data not publicly available.

Malawi

Starter Pack, 1998/99–1999/2000

Malawi's initial ISP in the wake of structural adjustment was the Starter Pack program. In place during the 1998/99 and 1999/2000 agricultural seasons, the Starter Pack grew out of the recommendations of the Malawi Maize Productivity Task Force, which had been established to explore policy options for addressing the country's chronic food shortages (Harrigan 2008). The task force identified declining soil fertility and maize productivity as two major contributors to the food shortage problem. The Starter Pack entitled all Malawi smallholder farm households to 15 kg of inorganic fertilizer, 2 kg of hybrid maize seed, and 1 kg of legume seed for free. The maize inputs were sufficient to plant about 0.1 ha of maize (Druilhe and Barreiro-Hurlé 2012; Harrigan 2008). The initial objectives of the program were to raise agricultural productivity by introducing farmers to "best bet" technologies in a risk-free way, to kick-start agricultural development, and to achieve national food self-sufficiency (Harrigan 2008; Levy 2005), not social protection (Dorward and Chirwa 2011).

National maize production increased markedly in Malawi in the years of the Starter Pack (likely due in part, but not entirely, to the program), but the program was unpopular with donors, who highlighted its high fiscal cost, negative effects on the development of private sector input markets, and late delivery, among other challenges (Harrigan 2008). Donor opposition, including pressure from the International Monetary Fund to reduce spending on the Starter Pack, eventually led to its scaling down and transformation into the Targeted Inputs Program (TIP) (Harrigan 2008).[24] Under TIP, the emphasis shifted from raising agricultural productivity and food self-sufficiency to providing a safety net for poor smallholder farm households.[25]

Targeted Inputs Program, 2000/01–2004/05

TIP was essentially a "targeted version of the Starter Pack" (Druilhe and Barreiro-Hurlé 2012, 18). Its scale varied with 1.5 million free input packs distributed in 2000/01, 1 million in 2001/02, 2.8 million in 2002/03 (following the 2002 food crisis), 1.7 million in 2003/04, and 2 million in 2004/05. This is in contrast to the 2.8 million input packs distributed each year of the Starter Pack (Harrigan 2008). In its last year (2004/05), the TIP input pack size increased to 25 kg of fertilizer, 5 kg of OPV maize seed, and 1 kg of legume seed.[26]

Agricultural Inputs Subsidy Program and Farm Input Subsidy Program, 2005/06–Present

Malawi's present-day ISP, the MFISP, also referred to as the AISP, was established in 2005/06. The program's core objectives are raising household and

national food security, food self-sufficiency, and incomes by improving resource-poor smallholders' access to improved agricultural inputs (Dorward and Chirwa 2011; Kilic, Whitney, and Winters 2015; Lunduka, Ricker-Gilbert, and Fisher 2013).

The number of smallholder farm households that MFISP has aimed to reach has varied over time, but has been 1.5 million per year during the three most recent agricultural years (2012/13 through 2014/15) (Logistics Unit 2015). Other key features of the program, including the total quantities of subsidized inputs distributed, the fertilizer subsidy rate, and program costs, are summarized in table 3A.4. As of 2014/15, beneficiary farmers were to each receive vouchers for fertilizer, maize seed, and legume seed:

- Two fertilizer vouchers: one for a 50 kg bag of NPK as basal dressing, and one for a 50 kg bag of urea as top dressing. When redeeming their vouchers for the fertilizer, farmers had to pay MK 500 per 50 kg bag top-up fee.
- One maize seed voucher for 5 kg of hybrid maize seed or 8 kg of OPV maize seed for free, although seed companies could apply a discretionary top-up fee of MK 100 on the voucher.[27]
- One legume seed voucher for 3 kg of soybean seed or 2 kg of other legume seed (beans, cowpeas, pigeon peas, or groundnuts) for free (Logistics Unit 2015).[28]

In August 2015, the Malawi government announced that the farmer contributions would increase to MK 3,500 per 50 kg bag of fertilizer, and MK 1,000 and MK 500 for the previously mentioned quantities of maize and legume seed, respectively. This is equivalent to a fertilizer subsidy rate of about 70 percent—much lower than the 90–95 percent subsidy rates that had prevailed in recent years (Logistics Unit 2015).

Beneficiary farmers redeem their fertilizer coupons at government-run outlets (Agricultural Development Marketing Corporation [ADMARC] and Smallholder Farmers Fertilizer Revolving Fund of Malawi [SFFRFM] locations) and their seed vouchers at registered, private agro-dealers' shops (Kilic, Whitney, and Winters 2015; Logistics Unit 2015). That is, fertilizer for MFISP is distributed through government, not private sector, channels.[29] Until 2013/14, all MFISP coupons were paper, but an electronic voucher (e-voucher), scratch-card based system was piloted for seed in six extension planning areas (EPAs) in 2013/14 and expanded to 18 EPAs in 2014/15. Fertilizer e-vouchers were piloted in 2014/15 in the six EPAs where seed e-vouchers had been piloted in 2013/14 (Logistics Unit 2015). The fertilizer e-voucher is to be expanded to eight districts and used to distribute 30,000 MT of the 150,000 MT of fertilizer intended for the 2015/16 MFISP.

Table 3A.4 Key Features of the Malawi Farm Input Subsidy Program, 2005/06–2014/15

Cropping year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Total fertilizer subsidized (MT), planned	137,006	150,000	170,000	170, 000	160, 000	160, 000	140, 000	154, 440	150, 000	150, 000
Total fertilizer subsidized (MT), actual	131,388	174,688	216,553	202,278	161,074	160,531	139,901	153,846	149,821	149,813
Total maize seed subsidized (MT)	—	4,524	5,541	5,365	8,652	10,650	8,244	8,582	8,268	8,434
Total legume seed subsidized (MT)	0	0	24	—	1,391	2,727	2,562	2,968	3,042	3,027
Redemption price (MK/50 kg maize fertilizer)	950	950	900	800	500	500	500	500	500	500
Redemption price (US$/50 kg maize fertilizer)	8.02	6.98	6.43	5.69	3.54	3.32	3.19	2.01	1.37	1.18
Fertilizer subsidy rate (%)	64	72	79	91	95	90	—	—	—	—
Total program cost (US$, millions)	55.71	88.69	114.62	274.92	114.6	127.47	151.25	207.03	168.21	126.83
Total cost as % of agricultural budget	—	61	61	74	62	61	52	38	53	52
Total cost as % of national budget	5.6	8.4	8.9	16.2	8.2	6.5	—	—	—	—

Sources: Dorward and Chirwa 2011; Logistics Unit 2015; Lunduka, Ricker-Gilbert, and Fisher 2013.
Note: All redemption prices converted from MK to US$ using the official exchange rate per World Development Indicators. For 2011/12 through 2014/15, program costs exclude government operational costs and voucher printing, and do not reflect funds recuperated through farmers' top-up fees. — = not available.

MFISP beneficiary selection and coupon allocations occur as follows (Kilic, Whitney, and Winters 2015; Lunduka, Ricker-Gilbert, and Fisher 2013; Wanzala-Mlobela, Fuentes, and Mkumbwa 2013). First, the Ministry of Agriculture and Food Security (MoAFS) allocates coupons to districts in proportion to their number of farm households. Second, within each district, the district commissioner, district agricultural development officer, traditional authorities, nongovernmental organizations (NGOs), and religious leaders determine how to allocate the district's coupons to EPAs within the district, and to villages within the EPAs. And third, within each village, beneficiary village residents are to be selected through community-based targeting in open forums. In general, MFISP beneficiaries are to be full-time smallholder farmers who cannot afford one or two bags of fertilizer at commercial prices (Dorward et al. 2008). Priority is to be given to resource-poor households (for example, those with elderly, HIV-positive, female, child, orphan, or physically challenged household heads or household heads taking care of elderly or physically challenged individuals) (Kilic, Whitney, and Winters 2015).

Nigeria

Federal Market Stabilization Program, 1999–2011

The federal government of Nigeria reintroduced fertilizer subsidies in 1999 with the establishment of the Federal Market Stabilization Program (FMSP), after having abolished fertilizer subsidies in 1997 due to their high fiscal cost (Liverpool-Tasie and Takeshima 2013).[30] Under the program, which ran through 2011, the federal government provided fertilizer to Nigerian state governments at a 25 percent subsidy. See table 3A.5 for the quantities of fertilizer nutrients distributed through the program each year from 2000 through 2008. The goal of the program was to improve farmers' timely access to fertilizer, in both quantity and quality (Wanzala-Mlobela, Fuentes, and Mkumbwa 2013). The FMSP was a universal ISP in that there were no targeting criteria, and in theory any farmer could obtain subsidized fertilizer through the FMSP; moreover, there was no cap on the quantity that an individual farmer could receive. But the quantity of subsidized fertilizer distributed to each state was rationed (Takeshima and Liverpool-Tasie 2015).

To obtain FMSP subsidized fertilizer, each state submitted its total fertilizer request to the federal government based on estimates of the farm area in the state and recommended fertilizer application rates (Takeshima and Nkonya 2014). The federal government then determined the quantity of subsidized fertilizer to allocate to each state. The federal government purchased fertilizer for the FMSP from importers through a tender process (Liverpool-Tasie and

Table 3A.5 Fertilizer Distributed through Nigeria's Federal Market Stabilization Program, 2000–08

Year	Subsidized fertilizer nutrients distributed (MT, thousands)
2000	54
2001	20
2002	52
2003	43
2004	91
2005	66
2006	117
2007	134
2008	255

Source: Takeshima and Nkonya 2014, based on information from the Nigeria Federal Department of Fertilizer.

Takeshima 2013). It then delivered and sold the fertilizer to the states at a 25 percent subsidy (Takeshima and Liverpool-Tasie 2015). States and local government areas could add their own subsidies on top of the federal subsidy, and use their resources to increase the quantities of subsidized fertilizer beyond the quantities allocated by the federal government. The typical subsidy rate by the time the fertilizer reached farmers was approximately 75 percent (Takeshima and Liverpool-Tasie 2015).

The fertilizer was mainly distributed to farmers through Agricultural Development Project outlets (a state-level public institution that provided extension services and inputs to farmers), but also distributed through other outlets. No vouchers were used in the distribution of FMSP fertilizer, and there was no seed component to the program. Late delivery and diversion and sale of fertilizer intended for the FMSP as commercial (unsubsidized) fertilizer were common, as was leakage, that is, the resale of FMSP fertilizer by subsidy recipients (Liverpool-Tasie and Takeshima 2013; Liverpool-Tasie 2014c).

Targeted Fertilizer Subsidy Voucher Pilot Programs, 2009–11

In the lead up to its 2010 pronouncement that it aimed to withdraw from fertilizer procurement by 2012 and instead support the development of private sector agro-dealer networks, in 2009 the federal government of Nigeria began piloting targeted fertilizer subsidy voucher programs in collaboration with select state governments. The pilot programs were run in the states of Kano and Taraba in 2009, with the states of Bauchi and Kwara added in 2010 (Wanzala-Mlobela, Fuentes, and Mkumbwa 2013). The FMSP continued to be implemented alongside the voucher pilot programs in these states, as well as in the states without pilot programs. To our knowledge, all of the

empirical evidence on the targeting and impacts of the pilot programs is based on the Kano and Taraba experiences, so we focus on those two programs in the remainder of this subsection.

The federal and state governments partnered with the International Fertilizer Development Center (IFDC), three major private fertilizer suppliers, and more than 150 agro-dealers to implement the Kano and Taraba State pilots (Liverpool-Tasie 2014c). The IFDC and federal and state governments determined what part of the FMSP fertilizer earmarked for each state to distribute through the voucher pilot program, in which selected smallholder farmers were given paper vouchers that they could redeem for a discount on fertilizer at participating agro-dealers' shops. The federal government still procured the fertilizer and delivered it to the states as in the standard FMSP; only the means of distribution to farmers differed (Liverpool-Tasie 2014a). (The rest of FMSP fertilizer earmarked for each state was distributed to farmers through the standard FMSP government distribution system.)

While the Kano and Taraba State pilot programs had these features in common, there were also three important differences between the programs. First, the number of bags of fertilizer and the value of the vouchers allocated to beneficiary farmers in the two states differed. In Kano State, each participating farmer was to get a ₦2,000 (US$13.50) discount on each of two 50 kg bags of NPK and one 50 kg bag of urea, for a total subsidy value of US$40.50 (or about 60 percent and 65 percent off the market price of NPK and urea, respectively) (Liverpool-Tasie 2014c). In Taraba State, participating farmers still got a ₦2,000 discount per bag, but were entitled to two 50 kg bags of NPK and two 50 kg bags of urea, for a total subsidy value of US$54. These represented subsidy rates of about 55 percent for both types of fertilizer, slightly lower than in Kano State (Liverpool-Tasie 2014a). In both states, farmers paid the difference between the voucher value and the fertilizer's market price.

A second set of differences between the two states' programs relate to the eligibility requirements and who received (and redeemed) the vouchers. In Kano State, which had a long history of farmer organizations, beneficiaries were required to be a member of such a group. Only one voucher was given to the entire farmer group. It then entitled every group member to the aforementioned fertilizer discounts. Any farmer group leader (chairperson, treasurer, or secretary) could redeem the voucher on behalf of all group members (Liverpool-Tasie 2014c). But in Taraba State, where farmer organizations were less well established, beneficiaries were only required to be members of some sort of organization or group (be it farmer-related or otherwise) (Liverpool-Tasie 2014b). Moreover, each beneficiary received his or her own vouchers. As will be discussed in the section on empirical evidence related

to the targeting of ISP fertilizer, these differences in who received vouchers had important implications for elite capture of the subsidy program benefits (Liverpool-Tasie 2014b).

Finally, the scale of the two pilot programs in 2009 differed. While the Kano State program aimed to reach 140,000 smallholders (Liverpool-Tasie and Salau 2013), the Taraba State program targeted only 76,000 (Liverpool-Tasie 2014b).

Growth Enhancement Support Scheme, 2012–Present

Drawing on the experiences of and lessons learned from the targeted fertilizer voucher pilot programs of 2009 to 2011, in 2012 the federal government of Nigeria established the Growth Enhancement Support Scheme (GESS), which scaled the pilot programs up to the national level with some important changes (Liverpool-Tasie and Takeshima 2013). First, instead of being paper-based, the GESS delivered vouchers to beneficiary farmers electronically through a mobile phone platform called the e-wallet system; farmers then used the vouchers to obtain subsidized inputs at their assigned redemption center (a selected private agro-dealer's shop).[31] Second, under GESS, the private sector was responsible for the procurement and distribution of the fertilizer (Liverpool-Tasie and Takeshima 2013). Third, the GESS included subsidies for maize and rice seed (Liverpool-Tasie and Takeshima 2013). GESS focused on "resource-constrained" farmers, and its objective was to provide a "series of incentives to encourage the critical actors in the fertilizer value chain to work together to improve productivity, household food security, and income of the farmer."[32]

At its launch in 2012, the GESS aimed to reach 5 million farmers per year for four years, and beneficiary farmers were to receive 25 kg of certified rice seed or 20 kg of certified maize seed for free, and two 50 kg bags of fertilizer at a 50 percent subsidy (Maur and Shepherd 2015). But seed supplies were insufficient to cover these quantities, so the seed quantities were reduced to 12.5 kg (Maur and Shepherd 2015). Another challenge faced by GESS is that many Nigerian smallholders live outside of mobile phone network coverage areas or do not own mobile phones; in response, offline processes are also being developed (IFDC 2014).[33] In 2013, GESS was implemented in all 36 Nigerian states as well as in the Federal Capital Territory, and involved 4.8 million farmers, 500,000 MT of fertilizer, and 23,000 MT of improved seed (IFDC 2013). See IFDC (2013) for more details on how GESS works.

With the transition to the new government of President Muhammadu Buhari in 2015, there have been some challenges with GESS. Agro-dealers participating in the program under former President Goodluck Jonathan have not been paid and the 2015 distribution of subsidized inputs has been delayed (Yusuf 2015).

Tanzania

Input subsidy programs were reintroduced in 2003/04 in Tanzania, though they were small (no data as yet available on quantities of fertilizer distributed under the program). Private companies tendered for particular areas; winning firms were allocated fertilizer and seed at fixed prices to provide to farmers. The fixed prices at which they purchased fertilizer at regional depots were below market price; transport costs and part of the cost of fertilizer were provided by the government as subsidies. The program ended in 2007/08 based on the conclusion that private traders were not passing along the full subsidy to targeted smallholder farmers. It was difficult for government to monitor this because fertilizer was also selling in rural areas through commercial markets, and hence it was difficult to ascertain whether prices paid by farmers were for commercial or subsidized fertilizer. The lack of transparency and ability to properly monitor the subsidy pass-through to farmers spelled this program's end.

This program was replaced by the National Agricultural Inputs Voucher Scheme (NAIVS), which started in 2008/09 for maize and rice. The program was launched in 56 districts, but because food prices remained high and volatile in the aftermath of the world food price rise, the program was expanded in 2009 to 65 districts for three years, with the aim to reach 2.5 million households in 2012. The program was almost entirely financed by the World Bank, and cost roughly US$80 million to US$100 million a year (World Bank 2014).

The objectives of the NAIVS were to improve farmers' access to modern inputs; to educate farmers on fertilizer's benefits; and to improve crop productivity for the main staple food in the area, mainly maize and rice.

The input package consisted of three vouchers: one for one 50 kg bag of urea; one for a 50 kg bag of diammonium phosphate (DAP) or two 50 kg bags of Minjingu rock phosphate (MRP) with a nitrogen supplement (farmers were supposed to choose); and one for 10 kg of hybrid or open-pollinated maize seeds or 16 kg of rice seeds, sufficient for half a hectare of maize or rice. Vouchers for each input had a face value equivalent to 50 percent of the market price of the respective input. The remaining 50 percent was to be paid by the farmers. Agro-dealers then submitted the vouchers to the district agricultural and livestock development officer for approval and then submitted them to the appointed bank for redemption.

The program targeted smallholder farmers cultivating not more than 1 ha. Priority was given to first-time fertilizer users, female-headed households, and relatively poor farmers (Msolla 2014). Each household was to receive fertilizer for three years only and then graduate from the program, in theory to a higher productivity trajectory.

The number of beneficiaries reached by the NAIVS is reported by Msolla (2014) as follows: 2008/09 (735,000 beneficiaries); 2009/10 (1.5 million); 2010/11 (2 million); 2011/12 (1.8 million); 2012/13 (640,873); and 2013/14 (932,100).

The modalities of fertilizer distribution under the NAIVS are described as follows by Pan and Christiaensen (2012):

> The central government allocates the vouchers to the target regions, which subsequently distribute it to their districts, which in turn distribute it to the villages in their district. At each level of government a special voucher committee is set up to allocate the vouchers to the lower levels based on the expected demand for inputs using historical production data for maize and rice as well as other related information such as the number of smallholder farmers who grow maize and rice and the average land size per farmer. The last step in the distribution is at the village level. First, the village council, in consultation with the village assembly, organizes the election of the village voucher committee (VVC), consisting of three men and three women. Then, the VVC draws up a list of beneficiary farmers for approval by the village assembly. After approval, the VVC issues the vouchers to the approved farmers, who can redeem them with local agro-dealers participating in the program.

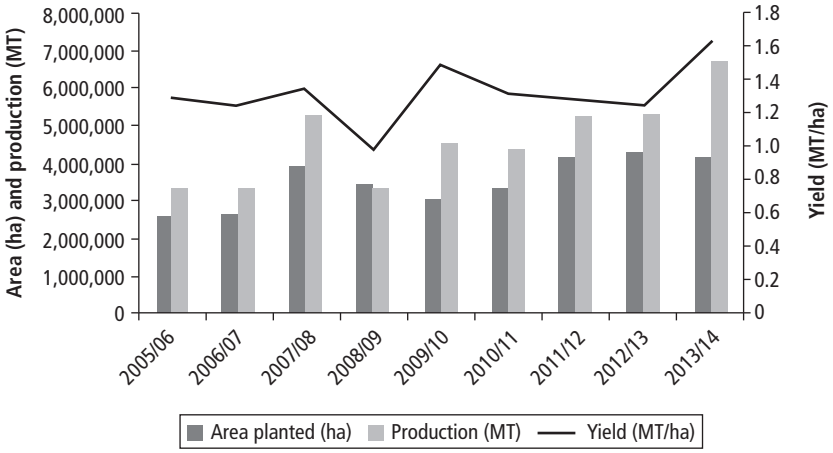
According to the guidelines, the VVC selects farmers who are able to cofinance the inputs purchased with the voucher; are literate; and do not cultivate more than 1 ha of maize or rice. Priority is given to female-headed households and households who have used little or no modern inputs on maize or rice over the past five years. As such, these criteria reflect the implicit dual objective of the program: to increase overall maize and rice output (for example, by focusing on noninput using, literate farmers who are more likely to have a higher marginal productivity), and to increase access to modern inputs among poor and vulnerable smallholders (for example, by giving priority to female-headed households).

NAIVS clearly increased fertilizer use and maize and rice production in Tanzania (World Bank 2014). Msolla (2014) reports that maize production rose from 0.5 MT per ha in 2007/08 to 2.0 MT per ha. But official Ministry of Agriculture data show the following annual figures for maize yield and production (figure 3A.2).

Except for the 2013/14 season, Tanzania maize yields have been stagnant over the past decade, even with the NAIVS program operating every year since 2008/09. Area expansion is the main form of production growth. Anecdotally, the small change in yield suggests a low crop response rate to fertilizer given that the program distributed between 100,000 and 200,000 added metric tons of fertilizer each year.

Roughly 3,855 agro-dealers were trained under the program on methods of fertilizer use, which they were to pass along to farmers participating in the program (Msolla 2014; World Bank 2014). Msolla (2014) notes several

Figure 3A.2 Maize Production in Tanzania, 2005/06–2013/14



Source: Jayne et al. 2016.

challenges facing the program: input requirements are higher than what the government can afford, indicating that the government is unable to continue a large-scale program without external assistance; vouchers were often distributed late under NAIVS, forcing households to apply fertilizer late and suffer some loss of yield as a result; and payments to input suppliers participating in the program often occurred late, causing friction between private firms and the government. There were also reports of adulteration and low quality of the inputs provided, and maize output markets and trade were restricted at times by the Government of Tanzania, reducing maize prices received by farmers and depressing the value to farmers of the added production due to NAIVS.

Zambia

Zambia's main ISP since structural adjustment has been the Zambia Farmer Input Support Program (ZFISP), originally called the Fertilizer Support Program. This program has been in place since 2002/03. The ZFISP is implemented by the Zambia Ministry of Agriculture and Livestock (ZMAL). The Ministry of Community Development, Mother, and Child Health has implemented its own, substantially smaller ISP since 2000/01: the Food Security Pack Program. We describe these programs below.

Farmer Input Support Program, 2002/03–Present

Established in 2002/03 in the wake of a severe drought in southern Africa, the ZFISP was originally envisaged as a temporary program to be phased out after three years (ZMACO, Agricultural Consultative Forum, and FSRP 2002). Instead, it has grown in scale over the last 13 years and has seemingly become a permanent feature of Zambia's agricultural policy landscape. (See table 3A.6 for key features of the ZFISP, including the number of intended beneficiaries, quantities of subsidized inputs distributed, and subsidy rates over time.) The ZFISP is a targeted ISP, with overall objectives "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" (ZMAL 2014, 6). The program is one of Zambia's two major agricultural sector poverty reduction programs, the other being the Food Reserve Agency, a maize marketing board and strategic food reserve.

Fertilizer and seed for maize production have been central to the ZFISP since its inception. In the program's early years (2002/03–2008/09), participating farmers received 400 kg of fertilizer (200 kg each of compound D and urea) and 20 kg of hybrid maize seed at a 50 percent subsidy. The input pack size was halved to 200 kg of fertilizer and 10 kg of hybrid maize seed from 2009/10 onward. Small quantities of rice seed were added to the program in 2010/11, and sorghum, cotton, and groundnut seed were added in 2011/12. In 2014/15 cottonseed was dropped and the groundnut seed quantity increased more than 10-fold (table 3A.6). Subsidy rates have varied over time, ranging from 50 to 79 percent for fertilizer, and 50 to 100 percent for seed (table 3A.6).

Based on the 2014/15 official eligibility criteria, targeted beneficiaries were to be small-scale farmers (that is, cultivating less than 5 ha of land); registered with ZMAL and actively engaged in farming; members of a farmer organization that had been selected to participate in the ZFISP; and not concurrent beneficiaries of the Food Security Pack Program. They also needed to have the financial means to pay the farmer share of the input costs (for example, approximately US$65 total for 200 kg of fertilizer and 10 kg of hybrid maize seed in 2014/15). In previous years of the program, there was also a requirement that beneficiaries have the capacity to cultivate a minimum land area (for example, 1 ha in 2012/13) (ZMAL 2012). Farmers apply to, pay their contributions to, and collect the subsidized inputs from their farmer organization. ZFISP beneficiaries are selected by camp agriculture committees, which include representatives of the local chief, farmer organizations, other community-based organizations; and representatives from public offices other than ZMAL, and for which ZMAL, through the camp extension officer, serves as the secretariat.[34]

Table 3A.6 Key Features of the Zambia Farmer Input Support Program, 2002/03–2014/15

Cropping year	Number of intended beneficiaries	Quantities of subsidized inputs (MT)					Fertilizer subsidy rate (%)	Seed subsidy rate (%)	Total program cost (US$, millions)	Total cost as % of agricultural spending	Total cost as % of national spending
		Fertilizer	Maize seed	Rice seed	Sorghum seed	Groundnut seed					
2002/03	120,000	48,000	2,400	0	0	0	50	50	4.04	10.4	0.5
2003/04	150,000	60,000	3,000	0	0	0	50	50	10.56	17.2	1.1
2004/05	115,000	46,000	2,500	0	0	0	50	50	20.52	26.8	1.6
2005/06	125,000	50,000	2,500	0	0	0	50	50	31.36	26.9	1.9
2006/07	210,000	84,000	4,234	0	0	0	60	60	51.08	25.5	2.4
2007/08	125,000	50,000	2,550	0	0	0	60	60	51.10	18.0	2.2
2008/09	200,000	80,000	4,000	0	0	0	75	50	131.37	37.6	3.5
2009/10	500,000	100,000	5,342	0	0	0	75	50	111.99	42.5	3.7
2010/11	891,500	178,000	8,790	30	0	0	76	50	122.78	29.9	3.4
2011/12	914,670	182,454	8,985	39	0	0	79	53	184.21	30.1	4.4
2012/13	877,000	183,634	8,770	143	60	150	—	—	165.68	50.3	3.1
2013/14	900,000	188,312	9,000	159	107	130	50	100	113.22	30.2	1.9
2014/15	1,000,000	208,236	10,000	127	119	1,357	—	—	—	—	—

Sources: ZMAL various years; ZMFNP various years.
Note: Input quantities rounded to the nearest metric ton. — = not available.

To date, no vouchers are used in the ZFISP, local agro-dealers are not involved, and inputs for the program are distributed through what is essentially a government system.[35] In recent years, the parastatal Nitrogen Chemicals of Zambia has provided the compound D for the program, and private firms are selected through a tender process to import the urea. Private sector transporters are then selected through a tender process to transport the inputs to main depots in the districts and ultimately to the farmer organizations.

From 2010/11 through 2013/14, the ZFISP aimed to reach about 900,000 beneficiaries per year. Over this period, spending on the program averaged 35 percent of the Zambian government's agricultural sector spending (see table 3A.6).

Food Security Pack Program, 2000/01–Present

The Food Security Pack Program is intended to target farmers who do not have the resources to pay the ZFISP farmer contribution or, when there was a minimum land requirement for ZFISP participation, farmers who could not meet it. More specifically, the Food Security Pack Program targets "vulnerable but viable" farmers, which it defines as households with less than 1 ha of land, adequate labor, not in gainful employment, and also having at least one of the following characteristics: female-, child/youth-, elderly-, or terminally-ill headed, or caring for orphans or disabled individuals (PAM 2005). In addition, participating farmers are trained in conservation farming techniques and are required to prepare their field(s) using these practices (PAM 2005). Community Welfare Assistance Committees or Area Food Security Committees select program beneficiaries.

The contents of a Food Security Pack vary by agroecological region but generally consist of seed and fertilizer to plant 0.5 ha of cereals (maize, rice, sorghum, or millet), legume seed for 0.25 ha, sweet potato vines or cassava cuttings, and, in areas with acidic soils, 100 kg of lime. Fertilizer quantities are either 50 kg or 100 kg depending on the cereal seed received (PAM 2005). The program's objective is "to empower the targeted vulnerable but viable households to be self-sustaining through improved productivity and household food security and thereby contribute to poverty reduction" (PAM 2005, 1). Beneficiaries are not required to make a cash contribution for the Food Security Pack inputs; rather, they are required to pay in-kind a fraction of the value of the inputs received (for example, 100 kg of maize for those receiving input packs containing maize seed).

The scale of the Food Security Pack Program has been much smaller than that of the ZFISP. While at its peak in 2003/04 it reached 145,000 households—nearly as many as the ZFISP (see table 3A.6), by the late 2000s and early 2010s the Food Security Pack Program received only enough funding to reach about

15,000 households a year (compared to 900,000 under the ZFISP) (Kasanga et al. 2010).

Although small, the Food Security Pack Program has been considerably more innovative than the ZFISP. For example, it has taken a more integrative approach to raising smallholder productivity and incomes by including a significant extension component (training farmers in conservation farming) and by including inputs other than just maize seed and fertilizer. In addition, since 2012/13, it has piloted in three districts an Expanded Food Security Pack Program, which utilizes e-voucher scratch cards redeemable at private agro-dealers' shops for the aforementioned inputs and a *chaka* hoe (a specialized hoe designed for digging planting basins, the hand-hoe variant of conservation tillage promoted in Zambia). The program also includes a social cash transfer component: Each beneficiary household receives ZMW100 (about US$16.25 in 2014) in January, near the peak of the lean season and when school fees are due.[36] The Expanded Food Security Pack Program has been funded by the Royal Norwegian Embassy in Lusaka; the pilot is due to end after the 2015/16 agricultural season, by which time the program hopes to have reached 27,000 households. Discussions are underway to determine if the Ministry of Community Development, Mother, and Child Health will adopt and roll out the Expanded Food Security Pack program model to other districts in Zambia after the pilot ends.

Annex 3B: Evidence of Targeting and Impacts

In the years since the 2005 sea change and revival of ISPs in Africa, the empirical literature on the targeting and impacts of the programs has been expanding rapidly. In this section we synthesize the findings from econometric- and simulation-based studies that estimate (a) the effects of various household, community, and other characteristics on the probability or level of participation in ISPs in Sub-Saharan Africa; and (b) the effects of participation in a given ISP (measured in various ways) on household- and more aggregate-level outcomes, including fertilizer and improved seed use, crop yields, area planted, production, crop prices, and wage levels.

Targeting

Eligibility criteria for ISP participation vary markedly across (and sometimes within) countries (table 3B.1). Some programs officially target "resource-poor" households (for example, Kenya's NAAIAP) or those that cannot afford fertilizer at unsubsidized prices (for example, Malawi's MFISP). Other programs officially

Table 3B.1 Empirical Findings on the Targeting of ISP Inputs

Country	Empirical findings
By household head gender	
Ethiopia	—
Ghana	No differences: A study of smallholder rice farmers in the Ghana's Volta region finds that approximately 25 percent of both beneficiaries and nonbeneficiaries are female, and gender had no significant c.p. impact on the likelihood of participation [G1]
Kenya	No FHH-MHH differences in probability of receiving NAAIAP voucher, c.p. [K1]
Malawi	No differences: No FHH-MHH differences in probability of receiving [M12, M24, M28], value or number of MFISP vouchers [M7, M28], or kg of MFISP fertilizer or maize seed [M16, M17, M24] received, c.p. HHs with female plot managers equally likely to participate in the MFISP as HHs with only male plot managers, c.p. [M20]
	Differences: FHH less likely to receive MFISP fertilizer or seed+fertilizer, c.p. [M8]. FHH receives 12 kg less MFISP fertilizer, c.p. [M3]. Respondents in FHH less likely to receive the MFISP, c.p. [M5]
Nigeria	No FHH-MHH differences in quantity of FMSP, KSVP, or TSVP fertilizer acquired, c.p. [N1, N2]
Tanzania	MHH significantly more likely to receive vouchers than FHH [T1]
Zambia	No FHH-MHH differences in receiving ZFISP fertilizer or hybrid maize seed, c.p. [Z1, Z2, Z3, Z4]
By landholding size	
Ethiopia	—
Ghana	Mean plot size for both beneficiary and nonbeneficiary smallholders in Volta is 2 ha, but after controlling for other factors there is a negative and statistically significant correlation between plot size and subsidy participation [G1]
	Mean total crop area among beneficiaries is slightly lower in the Northern region (3.7 ha versus 4.2 ha among nonbeneficiaries) [G1]
Kenya	HHs with more than 5 ha of land 7–9 p.p. less likely to receive NAAIAP voucher, c.p. [K1]. HHs with more land get slightly more NCPB fertilizer, c.p. (3.1 kg more per 1 ha increase in landholding) [K2]
Malawi	Value of MFISP vouchers higher among HHs with more land, c.p. [M7]. Probability of receiving MFISP vouchers increases by 1.3–1.6 p.p. with 1 ha increase in landholding, c.p. [M12]. Probability of participating in the MFISP and number of coupons received increases with HH landholding (at a decreasing rate), and highest among largest land quintile, c.p. HHs in this last group are 18.9 p.p. more likely to get the MFISP than HHs in the smallest landholding quintile [M28]
	1 ha increase in landholding raises FISP fertilizer acquired by 3.3–11.3 kg, c.p. [M3, M16, M17], but has no effect on kg of FISP maize seed [M16]
	Probability of MFISP receipt increases with the number of plots cultivated by the HH, c.p. [M20]
	Probability of receiving MFISP fertilizer voucher and kg of MFISP fertilizer acquired increases with HH area cultivated, c.p. [M24]
Nigeria	No c.p. landholding effects on quantity of FMSP fertilizer acquired [N1]. 1 ha increase in landholding raises fertilizer received through the KSVP and TSVP, c.p. (APE not reported) [N2]
Tanzania	No significant relationship between landholding size and HHs receiving vouchers (T1)
Zambia	HHs with more land get slightly more ZFISP inputs, c.p. (0.2 kg more hybrid maize seed [Z2] and 2.5 kg more fertilizer [Z5] per 1 ha increase in landholding). No c.p. landholding effect in some studies, for example [Z4]

(continued next page)

Table 3B.1 (continued)

Country	Empirical findings
By assets, wealth, or ex ante poverty status	
Ethiopia	—
Ghana	Asset wealth was found to be 44 percent greater among beneficiaries compared with those not receiving fertilizer subsidies in the cross-sectional data from the Volta region [G1]
Kenya	HHs in highest asset quintile 8–12 p.p. less likely to receive NAAIAP voucher, c.p. [K1]. No c.p. effect of farm assets on quantity of NCPB fertilizer [K2]
Malawi	Value of MFISP vouchers received lower among poor HHs, c.p. [M7]; some evidence that poor HHs less likely to receive FISP vouchers, c.p. [M8]. Poor HHs 1.9–2.8 p.p. less likely to receive MFISP vouchers, c.p. [M12]. HHs that consider themselves to be poor less likely to receive MFISP voucher and receive less MFISP fertilizer, c.p. [M24]
	[M3] finds that an increase in value of assets raises MFISP fertilizer acquired, c.p. But [M17] and [M24] find no c.p. effects of asset wealth on MFISP fertilizer acquired (or probability [M24]). [M16] find the same for MFISP maize seed, but find that MFISP fertilizer kg acquired is decreasing in asset wealth, c.p.
	[M20] find that probability of MFISP participation decreases with a wealth index and access to nonfarm labor income but increases with an agricultural implement access index and access to nonfarm nonlabor income, c.p.
	[M28] find that middle three wealth quintiles more likely to participate in the MFISP (by 6–10 p.p.) than poorest and richest wealth quintiles, c.p. No statistically significant difference in participation between poorest and richest wealth quintiles, c.p. But top four wealth quintiles all get significantly more FISP coupons, c.p., with the largest effect in quintile four [M28]
	An increase in the district poverty rate increases the percentage of HHs receiving the MFISP in 2007/08, but an increase in the district percentage of HHs reporting a food shortage or famine does not, c.p. [M6]
Nigeria	No c.p. asset (livestock) effects on quantity of FMSP (KSVP and TSVP) fertilizer acquired [N1, N2, N6]
Tanzania	Voucher recipients more likely to be nonpoor in the prior survey than nonrecipients [T1].
Zambia	Panel data regressions suggest no farm asset effects, c.p. [Z1, Z2, Z4]. Cross-sectional regressions suggest that ZFISP fertilizer and seed recipients have more farm assets, c.p. [Z3, Z10 for five provinces only]
By political factors	
Ethiopia	—
Ghana	More vouchers targeted to districts lost by the ruling party in the last presidential election, c.p.; vouchers received increases with the ruling party's margin of loss [G2]. Notably, the incumbent party that initiated the GFSP lost the following presidential election by a slim margin [G3]
Kenya	Some evidence that increase (decrease) in constituency-level electoral threat (support for runner-up) in last election reduces (increases) NAAIAP and NCPB fertilizer receipt, but election data questionable [K2]
Malawi	[M16] find that HHs in districts won by Bingu wa Mutharika in the 2004 presidential election got 13.2 kg (1.7 kg) more MFISP fertilizer (maize seed) in 2006/07 and 2008/09 than HHs in districts lost by Mutharika, c.p.

(continued next page)

Table 3B.1 (continued)

Country	Empirical findings
	[M23] finds no evidence that districts with more Mutharika core supporters were favored with MFISP vouchers, c.p., in 2008/09 (just before the 2009 election) relative to earlier and later years. Districts with more swing voters appear to have been allocated more MFISP vouchers in 2008/09, c.p., at the expense of districts with more opposition core supporters, c.p. Also, no evidence that core supporters were rewarded with more MFISP vouchers after the 2009 election, c.p.
	More HHs received the MFISP in 2007/08 in districts where the incumbent lost in 2004, c.p., but the winning party in 2004 had no c.p. effect [M6]
	[M5] find that respondents' partisan affinities in 2008 had no c.p. effect on their likelihood of receiving the MFISP in 2009
	[M17] find that HHs in communities with a resident MP get 7.5 kg more MFISP fertilizer, c.p., but [M28] find no c.p. of this on probability of participating in MFISP or number of coupons received
	HHs in villages with resident or recent visit of MP 2.7 p.p. more (2.5 p.p. less) likely to receive MFISP fertilizer voucher only (fertilizer and maize seed voucher), c.p. [M12]
Nigeria	1 km decrease in distance from LGA to the state governor's district of origin increases the mean FMSP fertilizer acquired by HHs in the LGA by 22–30 kg, c.p. [N6]
Tanzania	Vouchers disproportionately targeted to HHs having elected officials and village voucher committee members [T1]
Zambia	Through 2010/11, HHs in constituency won by the MMD (ruling party) in the last presidential election got 23.2 kg more ZFISP fertilizer, and 0.5 kg more per p.p. increase in MMD margin of victory, c.p. [Z6]
By social capital factors (nonpolitical)	
Ethiopia	—
Ghana	—
Kenya	—
Malawi	HHs with heads originating from outside the district 3.0–7.7 p.p. less likely to receive MFISP vouchers, c.p. [M12]
	1-year increase in time HH head has lived in the village raises MFISP fertilizer receipt by 0.09 kg, c.p. [M3]
	HHs with village head, VDC, or traditional authority in their networks 13–14 p.p. more likely to participate in the MFISP, c.p. [M28]
Nigeria	Relatives of farm group leaders (chairperson, secretary, or treasurer) get more subsidized fertilizer through the KSVP but not TSVP, c.p. [N2, N5]
Tanzania	Households more likely to receive vouchers if they participate in public meetings, are members of farmer associations, or talk to government officials at least once a month [T1]
Zambia	HHs related to chief/headman get 0.6 kg more ZFISP hybrid maize seed, c.p. [Z4]. No evidence of similar effects on ZFISP fertilizer acquired
By select other factors	
Ethiopia	—
Ghana	Age, experience (years farming), and plot fertility (self-described) are all roughly the same on average, but beneficiaries are 30 percent (1.5 km) closer to the nearest extension agent distributing vouchers. The negative correlation is statistically significant, all else held constant [G1]

(continued next page)

Table 3B.1 (continued)

Country	Empirical findings
Kenya	HHs that did not use fertilizer in previous year(s) 8–12 p.p. less likely to receive NAAIAP voucher, c.p. [K1]. 1 km increase in distance from motorable road reduces NCPB fertilizer by 19 kg, c.p. [K2]
Malawi	Value of MFISP vouchers received lower among maize net buyers, c.p. [M7]
	1 km increase in distance from major road increases probability of MFISP voucher receipt by 0.03 p.p., c.p. [M12]. 1 km increase in distance from nearest paved road raises MFISP fertilizer receipt by 0.08 kg, c.p. [M3]. But [M16] and [M17] find no c.p. effects of distance to paved road, district capital, or main market on kg of MFISP fertilizer or maize seed acquired
	An increase in soil quality in the HH's area is associated with an increase in the probability of participation in the MFISP and the MFISP coupons received, c.p. [M28]
Nigeria	1-hour increase in travel time to nearest 20k+ town reduces FMSP fertilizer by 0.7 to 1 kg, c.p. [N1]. 1 km increase in distance to main market raises fertilizer received through KSVP, c.p. (APE not reported) [N2]
Tanzania	—
Zambia	1 km increase in distance from feeder road reduces ZFISP fertilizer by 1.1–2.5 kg, c.p. [Z1]

Note: Results are APE and statistically significant at the 10 percent level or lower. "No effect" indicates no statistically significant effect at the 10 percent level or lower. Electoral threat is the share of votes won by the runner-up divided by the share of votes won by the presidential winner. See annex 3C for full references for the studies cited here, and for brief overviews of the data and methods used. APE = average partial effects; c.p. = ceteris paribus; FHH = female-headed household; FMSP = Federal Market Stabilization Program; GFSP = Ghana Fertilizer Subsidy Program; HH = head of household; KSVP = Kano State voucher program (in 2009); MHH = male-headed household; LGA = local government area; MFISP = Malawi Farm Input Subsidy Program; MMD = Movement for Multi-Party Democracy; NAAIAP = National Accelerated Agricultural Inputs Access Program; NCPB = National Cereals and Produce Board; p.p. = percentage point; TSVP = Taraba State voucher program (in 2009); VDC = village development committee; ZFISP = Zambia Farmer Input Support Program; — = no analyses to date.

give priority to female-headed households (for example, MFISP and Zambia's Food Security Pack Program). Still others have a minimum or maximum land-holding- or area cultivated-related eligibility criterion (for example, Zambia's ZFISP and NAAIAP). Given this heterogeneity, one approach would be to evaluate each ISP against its stated targeting criteria. In many cases, however, there is little correlation between the official targeting criteria and de facto characteristics of farmers and households receiving input subsidies (Kilic, Whitney, and Winters 2015; Pan and Christiaensen 2012; Ricker-Gilbert, Jayne, and Chirwa 2011; Sheahan et al. 2014).

Despite this disconnect, all programs share the common objective of raising use of the inputs distributed through the ISP. Another approach is to assess targeting performance against this goal. On average and other factors constant, the potential for positive impacts of ISPs on fertilizer use is greatest when they are administered in areas where the private sector has been inactive and among households that cannot afford fertilizer at commercial prices (Jayne et al. 2013; Mason and Jayne 2013; Mather and Jayne 2015; Ricker-Gilbert, Jayne, and

Chirwa 2011; Xu et al. 2009). ISPs are particularly effective at increasing fertilizer use when beneficiaries include female-headed households and relatively poor households, be it in land, assets, income, or consumption. We therefore begin this subsection with a synthesis of the empirical record on how these factors affect household participation in ISPs. We then turn to the empirical record on the politicization and elite capture of ISPs. Table 3B.1 summarizes empirical findings on the targeting of ISP inputs.

Targeting by Gender of the Household Head

Looking across the various country ISPs and studies, the evidence suggests that female-headed households and male-headed households are equally likely to participate in ISPs and receive the same quantity of inputs on average, other factors constant (see table 3A.3). This is the case for all reviewed studies: on Ghana's GFSP [G1]; Kenya's NAAIAP [K1]; Zambia's ZFISP [Z1 to Z4], and Nigeria's ISPs prior to the Growth Enhancement Support Scheme (GESS) [N1, N2] (see annex 3C for the full sources, cited here as initials). It is also true for most studies on Malawi's MFISP. Where there are differences for the latter program, the findings suggest that female-headed households are less likely to receive MFISP inputs or receive a smaller quantity of MFISP inputs [M3, M5, M8]. Thus, ISPs in Sub-Saharan Africa generally fail to meet the criterion of favoring female-headed households.

Targeting by Landholding Size

The empirical record suggests that households with more land are more likely to receive ISP inputs or receive a larger quantity of such inputs on average (see table 3B.1). Of the more than 70 studies reviewed, only one suggests that households with more land are *less* likely to receive ISP inputs [K1], and only a handful suggest that an increase in landholding size has no effect on ISP receipt (see table 3B.1). But despite the consistent findings that households with more land are favored by the programs, the landholding effects are small: A 1 ha increase in household landholdings is associated with increases in subsidized fertilizer received of just 2.5–11.3 kg on average under Kenyan, Malawi, and Zambian programs. With recommended fertilizer application rates of 400 kg per ha in Zambia, for example, these effects are minimal.

Perhaps more striking are the unconditional probabilities of participation in ISPs by landholding size. There is a much larger spread across landholding quintiles in the probability of participation in the ZFISP than in the MFISP. While only 13 percent of Zambian smallholders in the lowest landholding quintile participated in the ZFISP in 2010/11, 43 percent of their Malawi counterparts participated in the MFISP in 2009/10. This is compared with 47 percent and 62 percent of Zambian and Malawi smallholders, respectively, in the largest

landholding quintile (a 34 percentage point spread for Zambia but only 19 percentage points for Malawi). This may be related to the minimum landholding requirement for the ZFISP (0.5 ha in 2010/11) or the broader coverage of the MFISP (which reached 54 percent of smallholders during the years in question compared with just 30 percent for the ZFISP). While participation in ISPs is higher among households with more land, the extent to which this is the case varies considerably across countries.

But participation rates alone can mask even larger disparities in the share of subsidized inputs received by households in different landholding quintiles. Even in countries where the input pack size is supposedly standardized (for example, 200 kg per household in Zambia in 2010/11 and 100 kg per household in Malawi throughout the duration of the MFISP), the quantities received often vary markedly across beneficiary households. Households with more land are often both more likely to receive inputs from the programs and receive larger quantities, on average, upon participating (Mason and Jayne 2013; Mason and Ricker-Gilbert 2013; Ricker-Gilbert, Jayne, and Chirwa 2011). As shown in annex 3A, Zambian smallholders in the smallest landholding quintile garner just 6 percent of all ZFISP fertilizer distributed, while those in the largest landholding quintile (who are most likely to be able to afford fertilizer at commercial prices) receive 41 percent of it. This exacerbates crowding out of commercial input demand by the programs, reduces impacts on total fertilizer use (and hence incremental maize production), and attenuates poverty reduction effects.

Targeting by Assets, Wealth, or Ex Ante Poverty Status

After controlling for landholding size and other factors, the empirical evidence on the effects of assets, wealth, and ex ante poverty status on ISP receipt is mixed, especially in Malawi's case (see table 3B.1). While some studies for Malawi suggest that relatively poorer (wealthier) households are less (more) likely to receive MFISP inputs or receive smaller (larger) quantities [M3, M7, M8, M12, M24, M28], some find the opposite [M16, M20], and still others find no wealth effects at all [M16, M17]. In a cross-sectional study of GFSP receipts, it was found that asset wealth in Ghana's Volta region was 44 percent greater among beneficiaries compared with those not receiving fertilizer subsidies [G1]. There is no evidence of wealth-related targeting in Nigeria's pre-GESS ISPs (see table 3A.3). De facto targeting under Kenya's NAAIAP favored households in the bottom four wealth quintiles [K1], while no farm asset effects are found for the country's universal National Cereals and Produce Board (NCPB) fertilizer subsidy program [K2]. Cross-sectional evidence from Zambia suggests that more farm assets are associated with receiving more ISP fertilizer and seed, but these estimated effects are not statistically significant after controlling for time-constant farmer

characteristics (see table 3B.1). Differences in methodology and the definitions of assets, wealth, or poverty measures likely underlie many of the varying results from Malawi as well.

In the most detailed study of the targeting of MFISP to date, Kilic, Whitney, and Winters (2015, 29) argue that Malawi's "FISP is not poverty targeted in that it does not exclusively target the poor or the rich at any level of the programme administration … The multivariate analysis of household programme participation reinforces these findings and reveals that the relatively well off in terms of wealth and landholdings, rather than the poor or the wealthiest … have a higher likelihood of program participation and, on average, receive a greater number of input coupons." In Zambia, targeting is decidedly not pro-poor, since smallholder households in the lowest income per adult equivalent quintile received just 5 percent of all ZFISP fertilizer in 2010/11, while those in the highest quintile received 42 percent of it (Mason and Tembo 2015), mirroring the landholding distribution.

Overall, the empirical record for most ISPs suggests little or no targeting by assets or wealth, on average, and holding other factors constant. But there is some evidence that the wealthiest households were less likely to receive subsidized inputs under Kenya's NAAIAP, which explicitly sought to reach resource-poor farmers.

Targeting and Political Factors

It is widely believed that ISPs in Sub-Saharan Africa are politicized. The empirical record shows which groups of voters—core supporters of the incumbent party, swing voters, or core supporters of the opposition—are actually targeted. Based on the findings in table 3B.1, there is considerable evidence of politically motivated targeting of ISP inputs, but the groups targeted vary across countries, and in Malawi's case studies reach different conclusions about which groups are targeted. In both Ghana and Kenya, empirical evidence suggests that areas with more opposition supporters in the last presidential election get significantly more subsidized fertilizer [G2, K2]. But the political logic to such targeting is questionable since the political payoff to targeting opposition (versus swing voter) areas are likely to be small. Notably, for example, the incumbent party that initiated the GFSP lost the following presidential election by a slim margin in 2008 [G3]. In Zambia, by contrast, results based on multiple nationally representative surveys (both panel and cross-sectional) consistently suggest that from the late 1990s through 2010, smallholder households in constituencies won by the ruling party (at that time the Movement for Multi-Party Democracy, or MMD) in the last presidential election received significantly more (23 kg) subsidized fertilizer than those in areas lost by the ruling party. Moreover, the quantity of subsidized fertilizer received increased with the

ruling party's margin of victory [Z3, Z6]. The findings from Malawi related to which groups of voters and partisans are targeted are too mixed to draw general conclusions, but the disparate findings are partially driven by differences in data and methods, and in the years under consideration (see table 3A.3). But for Malawi and Nigeria, there is some evidence that communities with resident elected leaders or communities that are geographically closer to the hometown of those leaders (for example, members of parliament in Malawi and state governors in Nigeria) receive significantly more subsidized fertilizer on average, other factors constant [M12, M17]. Overall, there is mounting empirical evidence of the politicization of ISPs in Sub-Saharan Africa, but the politicization varies across countries as well as within countries over time (Chinsinga and Poulton 2014, [M23]).

Targeting, Social Capital, and Elite Capture

In addition to the consistent findings that households with more land get more ISP inputs and the findings in some countries that wealthier households get more, empirical evidence from several Sub-Saharan African countries suggests that social capital also leads to "elite capture" of ISP benefits. In Tanzania, for example, Pan and Christiaensen (2012) found that 60 percent of the households receiving input vouchers contained a village official as a member. They also found that households with elected officials and voucher committee members were 1.7 and 4 times more likely to receive input vouchers than households without such members. Similarly, evidence from Zambia and Malawi suggests that households with links to traditional authorities are more likely to receive input subsidies [Z4, M28]. In Malawi, "locals" (either because they originate from the village or have lived in the village longer than others) are favored. In Nigeria, relatives of farm group leaders get more subsidized fertilizer under the Kano State voucher pilot program (where a single voucher was given to the farmer group) but not under the Taraba State program (where farmers were each given their own vouchers) [N2, N5]. Thus, in all Sub-Saharan African countries where this issue has been investigated empirically, there is evidence that social capital influences access to subsidized inputs.

Household-Level Effects of ISPs

Household-Level Effects on Fertilizer and Improved Seed Use

One of the first sets of ISP impacts to be empirically investigated was the effect of the programs on household demand for fertilizer at commercial (unsubsidized) prices. Originally investigated by Xu et al. (2009, [Z7]), and followed by

numerous later studies, empirical assessments of how much subsidized fertilizer "crowds in" or "crowds out" commercial fertilizer demand are based on the following relationship (3B.1):

$$\frac{\partial total}{\partial ISP} = \frac{\partial ISP}{\partial ISP} + \frac{\partial comm}{\partial ISP} = 1 + \frac{\partial comm}{\partial ISP} \tag{3B.1}$$

in which *total* is the quantity of fertilizer demanded, *ISP* is the quantity of ISP fertilizer acquired, *comm* is the quantity of commercial fertilizer demanded, and δ indicates a partial derivative.[37] The term $\frac{\partial comm}{\partial ISP}$ is estimated by regressing *comm* on *ISP* and other factors, and using econometric techniques to correct for the potential endogeneity of ISP fertilizer to commercial fertilizer demand. A negative (positive) and statistically significant partial effect of *ISP* on *comm* in this regression indicates crowding out (crowding in). When there is crowding out (in), a 1 kg increase in subsidized fertilizer acquired by a household leads to a less (more) than 1 kg increase in total fertilizer demand. Thus understanding the crowding out and in effects of ISPs is critical for understanding the programs' impacts on fertilizer use and thus on the incremental production of the crop(s) to which the fertilizer is applied.

Looking across multiple relevant studies for Sub-Saharan Africa, only two cases show evidence of crowding in: under the Kano state voucher pilot program in Nigeria [N2] and in areas with low private sector commercial retailing activity in Zambia [Z7].[38] All other studies [K2, M2, M3, N1, N7, Z1] suggest crowding out of commercial fertilizer demand by subsidized fertilizer in Kenya, Malawi, Nigeria (under the FMSP), and Zambia, and similarly for improved maize seed in Malawi and Zambia [M16, Z2].[39] In general, the extent to which ISP inputs crowd out commercial demand is lower among female-headed households, households with less land or fewer assets, households that did not previously purchase the inputs, in areas with less private sector fertilizer retailing activity, and in areas that have lower agroecological potential. That adverse effects on the private sector are less common in lower potential areas also raises questions on the long-run potential of ISPs in these areas. Specifically, what is the likelihood of sustaining a commercial market where fertilizer use may be sensible only at subsidized prices?

The crowding out effects vary considerably across countries where it has been found. Estimates suggest that an added 100 kg of ISP fertilizer crowds out 42–51 kg of commercial fertilizer in Kenya [K2], 18 kg in Malawi [M2], 19–35 kg in Nigeria under the FMSP [N7]. The substantially larger crowding out effects in Kenya are likely because the country's private sector fertilizer markets were already well developed and most farmers were already using fertilizer prior to the reintroduction of fertilizer subsidies there [K1, K2].

Thus, though there are a few findings of crowding in, the evidence suggests that most ISPs crowd out commercial demand for subsidized inputs. That is, an additional ton of fertilizer (improved seed) distributed through input subsidy programs raises fertilizer (improved seed) use, but by less than 1 ton.

More recently, some studies have estimated that crowding out of commercial fertilizer sales may have been substantially underestimated due to fertilizer that has been diverted from subsidy program channels into what can be mistaken for commercial sales (Jayne et al. 2013; Mason and Jayne 2013). Both in Malawi and Zambia, comparing the official subsidized fertilizer distribution volumes and the estimated volume of subsidized fertilizer received by farmers according to nationally representative survey data suggests that diversion of 25–35 percent of subsidized fertilizer is common. Diversion of program fertilizer has important income distributional effects, with program implementers receiving a major part of the program benefits rather than farmers (Jayne et al. 2015).

While those studies focus on crowding in and out of commercial *demand*, there have yet to be any overall studies of how much ISPs encourage or deter private sector investment in input distribution.[40] The conventional wisdom is that ISPs distributing inputs through parallel government channels are more likely to crowd out private sector market participation, but ISPs operating through vouchers redeemable at private agro-dealers are more likely to crowd in private sector participation. But little empirical evidence either supports or refutes this claim. A study on this topic is underway in Tanzania, but otherwise the subject remains a large knowledge gap.

Household-Level Effects on Crop Yields

In addition to raising the use of fertilizer and improved seed, another common ISP goal is to raise the productivity of the crops for which these inputs are intended. Despite this goal's centrality, the econometric evidence on these effects is surprisingly thin (table 3B.2).[41] In the countries where this issue has been examined (Kenya, Malawi, and Zambia), the findings suggest positive ISP effects on maize yields [K3, M7, M13, Z3]. There is also some evidence of positive spillovers of ZFISP fertilizer on the yields of nonmaize crops in Zambia [Z3]. And while participation in Malawi's MFISP raises the value of crop output per hectare [M20], this is not the case for Kenya's NAAIAP, where it appears that positive increases in maize yields are offset by reduced productivity of other crops [K3].

Comparing ISP yield impacts across countries is difficult due to the different ways in which ISP participation is measured, differences in econometric approaches, and the difficulty in computing effect sizes given that many studies do not report standard errors. We can conclude from the available evidence, however, that ISPs do raise maize yields. But crowding out by and

Table 3B.2 Empirical Findings on the Household-Level Effects of ISPs

Country	Empirical findings
Fertilizer and improved seed use (accounting for crowding out)	
Ethiopia	Evidence suggests no significant crowding out impact on improved seed or fertilizer use unless HHs were able to participate in both a public works program and OFSP. The probability of such households using improved seeds is estimated at 8.2 percent, roughly 5 p.p. greater than nonparticipants, c.p. The probability of participants in both programs using fertilizer is 27 percent, 11 p.p. higher than nonparticipants, c.p. [E1]
Ghana	To the best of our knowledge, no studies account for crowding effects
Kenya	Crowding out (fertilizer): 49 (58) kg increase in fertilizer use per 100 kg increase in NAAIAP (NCPB) fertilizer, c.p. [K2]. Crowding out of commercial fertilizer purchases worse in medium to high potential zones, for MHHs, and for HHs in top half of land or assets distribution [K2]. No known analysis for improved seed use
Malawi	Crowding out (fertilizer): 78 (82) kg increase in fertilizer use per 100 kg increase in MFISP fertilizer, c.p., based on 2 (3) waves of HH panel survey data [M3, M2]. Crowding out worse among HHs with more assets [M3], in high PSA than low PSA areas [M2], and among HHs in top 50 percent of landholding distribution [M2]
	Crowding out (seed): 42 kg increase in improved maize seed use per 100 kg increase in MFISP maize seed received, c.p. [M16]. Simulation results in [M26] consistent with this general finding of seed crowding out
	Other: No cross effect of MFISP fertilizer on improved maize seed use. Increase in value of MFISP vouchers received raises maize fertilizer use intensity, c.p. [M7]
	In HHs that receive MFISP fertilizer (but do not buy commercial fertilizer), no difference in probability of fertilizer use between male- vs. female-controlled plots, c.p. [M11]
	No c.p. effects of MFISP vouchers on adopting modern maize varieties overall (MHH + FHH pooled) but receiving maize seed + fertilizer MFISP voucher increases probability of modern maize variety use on plots in FHHs by 92.4 p.p., c.p. [M12]
	[M13] suggest that MFISP fertilizer increases the probability and intensity of fertilizer use, c.p., but [M21] suggest it increases the probability of fertilizer use by 37 p.p. but has no c.p. effect on the kg or kg/ha of fertilizer used
	The effect of MFISP participation on fertilizer use is larger on plots managed by women than those managed by men, c.p. [M20]
Nigeria	Crowding out: 100 kg increase in FMSP fertilizer reduces probability of commercial fertilizer use by 10–21 p.p., but has no effect on quantity of commercial fertilizer used among users, c.p. Overall effect not reported [N1]. Earlier working paper results suggest overall crowding out effect of 19–35 kg per 100 kg of FMSP fertilizer [N7]
	Crowding in: 100 kg increase in KSVP raises commercial fertilizer purchases by 26 kg, total fertilizer acquired by 126 kg [N2], and the probability of using improved maize or rice seed by 8 p.p., c.p. [N3]
Tanzania	—
Zambia	Crowding out (fertilizer and seed): 87 (51) kg increase in fertilizer (hybrid maize seed) use per 100 kg increase in ZFISP fertilizer (hybrid seed), c.p. [Z1, Z2]
	Crowding out (in) of commercial fertilizer purchases by ZFISP in high (low) PSA areas, c.p. [Z7] or worse in high PSA than low PSA areas, and among MHHs and HHs with more than 2 ha of land [Z1]
	Other: No cross effect of ZFISP fertilizer on commercial maize seed use [Z2]. 10 kg/ha increase in fertilizer application rate per 100 kg increase in ZFISP fertilizer, c.p. [Z3]

(continued next page)

Table 3B.2 (continued)

Country	Empirical findings
Crop yields	
Ethiopia	Estimated yield impacts for maize varies regionally and ranges from 3.8 to 4.5 marginal kg of cereal per kg of fertilizer applied [E2]
Ghana	Land productivity is similar between subsidy program recipients and nonrecipients, but labor productivity of participants is lower[a]
Kenya	NAAIAP participation raises maize yields by 299–721 kg per acre, c.p. (see source note for caveat) [K3]. No c.p. NAAIAP effects on net crop income per acre [K3]. No analyses to date for NCPB
Malawi	Receiving standard MFISP input pack raises maize yields by 447 kg per ha, c.p. [M7]
	Access to MFISP fertilizer raises maize yields, c.p. [M13]
	MFISP participation raises the value of crop output/ha by 13–17 percent, and there is no differential effect by plot manager gender, c.p. [M20]
Nigeria	—
Tanzania	—
Zambia	74.3 kg/ha increase in maize yield per 100 kg increase in ZFISP fertilizer, c.p.; small, positive spillovers on yields of other crops [Z3]. Late delivery of ZFISP fertilizer reduces technical efficiency and maize yields by 4.2 percent c.p., resulting in 84,924 MT of foregone maize production in 2010/11 [Z11, cross-section]
Crop area planted	
Ethiopia	—
Ghana	—
Kenya	No c.p. NAAIAP effects on maize or total area cultivated, or on the number of different field crops grown (a rough proxy for crop diversification) [K3]. No analyses to date for NCPB
Malawi	Maize MFISP voucher recipients devote larger shares of land to maize, especially improved varieties, and tobacco, and smaller shares of land to other crops, especially legumes, c.p. [M8]
	Some evidence that MFISP access incentivizes maize intensification and reductions in maize area and share of area planted, c.p. [M13]. Similar findings in [M21]—for example, participation in MFISP reduces the share of area planted with maize by 23 p.p. each for improved and traditional varieties, increases share of area planted with legumes and tobacco by 37 and 15 p.p., respectively, and reduces the share of area planted with other crops by 5 p.p. But no c.p. effects on crop diversification [M21]
Nigeria	—
Tanzania	—
Zambia	0.07 ha increase in maize area planted per 100 kg increase in ZFISP fertilizer, c.p. [Z3]. No c.p. effect on area planted with other crops [Z3], groundnuts [Z8], or cotton [Z12]
Crop production	
Ethiopia	—
Ghana	—
Kenya	NAAIAP participation (that is, receiving 100 kg of fertilizer and 10 kg of improved maize seed) raises main season maize kg harvested by 187–533 kg (estimates vary by estimator; FE estimate is 361 kg) and raises maize share of value of crop production by 2–5 p.p., c.p. No c.p. effect on net crop income [K3]

(continued next page)

Table 3B.2 (continued)

Country	Empirical findings
Malawi	165 kg increase in maize output per 100 kg increase in MFISP fertilizer, c.p. [M17]
	100 kg increase in MFISP fertilizer raises the 10th, 25th, 50th, 75th, and 90th percentiles of maize production by 75 kg, 111 kg, 204 kg, 276 kg, and 261 kg, respectively, c.p. [M18]
	HHs receiving MFISP coupons for free had maize production that was 43 percent higher and were less (more) likely to be maize net buyers (net sellers), c.p. [M14]
	MFISP fertilizer has small, positive effects on tobacco production and net value of rainy season total crop production, c.p. [M17]
Nigeria	—
Tanzania	—
Zambia	188 kg (106 kg) increase in maize output per 100 kg increase in ZFISP fertilizer (10 kg increase in ISP hybrid maize seed), c.p.; small, positive effects of ZFISP fertilizer on output of other crops, and on net crop income [Z3, Z4, Z13]. In Gwembe District, 224 kg increase in maize output per 100 kg increase in ZFISP inputs (seed or fertilizer) [Z9]
Food security and nutrition	
Ethiopia	Results are mixed. Participation in public works and OFSP is associated with 0.4 fewer months of food security over two years, but participants acquire 230 (10 percent) more calories per week than nonparticipants, and both relationships are significant at the 5 percent level or lower, c.p. [E1]
Ghana	—
Kenya	—
Malawi	HH participation in MFISP raises per capita nonfood spending by 125 percent but has no c.p. effect on per capita food consumption or health-related expenditures, or on dietary diversity [M21]
	Among HHs with preschool-aged children, participation in MFISP increases weight-for-height by 2.1 standard deviations overall, and 3.1 (1.5) for male (female) children, on average, c.p., suggesting reductions in wasting as a result of MFISP [M21]
Nigeria	—
Tanzania	—
Zambia	No analyses to date, but study in progress
Incomes, poverty, and assets	
Ethiopia	Public work participants experience roughly 45 percent growth in asset wealth over three-year period, but nonparticipant asset growth is 23 p.p. greater and this difference is significant at the 1 percent level [E1]
Ghana	—
Kenya	NAAIAP participation has no c.p. effect on total HH income or US$1.25 per day poverty incidence but reduces US$1.25 per day poverty severity by 4–11 p.p. [K3]. See note on [K6]
Malawi	Starter Pack participation reduced HH per capita income by 8.2 percent, but receiving full MFISP input pack raises HH per capita income by 8.2 percent, c.p. [M10]
	Increase in MFISP fertilizer has no c.p. on HH assets, off-farm income, or total (farm + off-farm) income [M17]
Nigeria	—
Tanzania	—

(continued next page)

Table 3B.2 (continued)

Country	Empirical findings
Zambia	100 kg of ZFISP fertilizer (10 kg of ZFISP hybrid maize seed) raises total HH income by 3.9 percent (1.1 percent) and reduces US$2 per day poverty severity at that HH level by 1.4 (0.7) p.p., c.p. No c.p. ZFISP seed or fertilizer effects on US$2 per day poverty incidence. Similar (and slightly larger impacts on poverty severity) when the US$1.25 per day poverty line is used [Z4, Z13]
Soil fertility management practices, fallow land, and forests	
Ethiopia	—
Ghana	No evidence of FSP impact on broadly defined soil and water management after controlling for hired and household labor and other factors. Correlation is positive, but not significant [G1]
Kenya	—
Malawi	MFISP fertilizer has no c.p. effect on probability or intensity of organic manure use [M13, M15] or on intercropping [M13]
	Access to MFISP fertilizer might incentivize planting new trees but cutting down naturally occurring trees, c.p. [M13]
	Access to full set of MFISP maize coupons (seed + fertilizer) reduces forest clearing in both total hectares per household and hectares per capita, c.p., but receiving only seed or only fertilizer coupon has no c.p. effect [M9]
Nigeria	—
Tanzania	—
Zambia	An increase in ZFISP fertilizer reduces fallowing [Z3, Z14] and intercropping, increases continuous maize cultivation on the same plot, and has no effect on use of animal manure, c.p. [Z14]
Dynamic or enduring effects	
Ethiopia	—
Ghana	—
Kenya	—
Malawi	Long-run (4-year) c.p. effect of 100 kg increase in MFISP fertilizer on maize production of 481 kg (165 kg contemporaneous + 316 kg lagged/enduring effects) [M17], and on commercial fertilizer demand of 13 kg (−7 kg contemporaneous crowding out + 20 kg lagged/enduring effects) [M28]. But [M28] find no lagged effects on maize production
	No contemporaneous or enduring c.p. effects of MFISP fertilizer on HH assets, off-farm, or total (farm + off-farm) income [M17]. Small, positive contemporaneous effect on HH tobacco production and net value of rainy season total crop production but no enduring effects, c.p. [M17]
Nigeria	—
Tanzania	—
Zambia	No analyses to date, but study planned for 2016

Note: Results are average partial effects and statistically significant at the 10 percent level or lower. See annex 3C for full references for the studies cited here, and for brief overviews of the data and methods used. c.p. = ceteris paribus; FE = fixed effects; FHH = female-headed household; FMSP = Federal Market Stabilization Program; FSP = Fertilizer Subsidy Program; HH = head of household; ISP = input subsidy program; KSVP = Kano State Voucher Program; MFISP = Malawi Farm Input Subsidy Program; MHH = male-headed household; NAAIAP = National Accelerated Agricultural Inputs Access Program; NCPB = National Cereals and Produce Board; OFSP = Other Food Security Program; p.p. = percentage point; PSA = private sector activity (fertilizer retailing); TSVP = Taraba State Voucher Program in 2009; ZFISP = Zambia Farmer Input Support Program; — = no analyses to date.
a. Wiredu, Zeller, and Diagne 2015.

late delivery of ISP inputs [Z7, Z11] are likely attenuating these effects, as are poor soil quality and the minimal use of complementary practices to raise crop yield response to fertilizer (Burke 2012; Jayne and Rashid 2013; Marenya and Barrett 2009).

Household-Level Effects on Crop Area Planted

The empirical record is mixed whether ISPs induce an expansion of crop area planted or changes in the shares of land planted to different crops (see table 3B.2). In land-scarce Kenya, NAAIAP appeared to have no effect on farmers' area planted to maize or total area planted, on average and other factors constant [K3]. In relatively land-abundant Zambia, the ZFISP incentivizes an expansion of total and maize areas, such that the maize share of total area increases without affecting the area of land (in absolute terms) devoted to other crops [Z3, Z8, Z12]. The results from Malawi are again difficult to generalize. While [M8] suggests that smallholders increase the share of land devoted to maize in response to MFISP, [M13] and [M21]—which draw on different data sets from each other and from [M8]—suggest that MFISP incentivizes maize intensification and a reduction in the maize share of total area planted. We thus conclude that ISPs have heterogeneous effects on the area planted to maize and other crops.

Household-Level Effects on Crop Production

Raising crop production is another core goal of most ISPs. The empirical findings summarized in table 3B.2 suggest that ISPs have had modest, positive effects on household-level maize production in all countries where this issue has been examined (Kenya, Malawi, and Zambia). Here the effects are somewhat easier to compare across countries, though still not perfectly. In Kenya, participation in NAAIAP raises maize production by 361 kg on average, other factors constant [K3].[42] The increases in Malawi (165 kg of maize per 100 kg of MFISP fertilizer) and Zambia (188 kg of maize per 100 kg of ZFISP fertilizer) are considerably smaller [M17, Z3]. While this could be due to minor methodological differences or because the latter two estimates are for fertilizer only whereas the Kenya-NAAIAP estimate is for fertilizer *and* seed, differences in the design and implementation of the three ISPs might also contribute to the differences in the estimated impacts on maize production. Of the three programs, only Kenya's NAAIAP successfully targeted resource-poor farmers and distributed inputs to farmers through vouchers redeemable at registered agro-dealers' shops. These differences, coupled with ecological differences leading to higher maize yield response to fertilizer in Kenya compared with Zambia and Malawi, may have contributed to the larger impacts of Kenya's ISP on maize production despite the larger crowding out effects there [K3].

Looking beyond the impacts on maize alone, the empirical evidence on the effects of ISPs on net crop income (or net value of crop production) is more variable. Estimates for Kenya's NAAIAP suggest negligible impacts on net crop income overall but increased net crop income among the poor, while evidence from Malawi and Zambia suggests that the MFISP and the ZFISP, respectively, do have small positive effects on net crop income overall [K3, M17, Z13].

Finally, looking "beyond the mean," quantile regression results from Malawi suggest that MFISP fertilizer has larger effects on higher percentiles of the maize production distribution. For example, a 100 kg increase in MFISP fertilizer raises the 10th percentile of the maize production distribution by only 75 kg but it raises the 90th percentile by 261 kg on average [M18].

In general, the empirical record suggests that ISPs have modest, positive effects on maize production and on net crop income for some population segments. But these effects vary at different points in the distribution of maize production.

Household-Level Effects on Food Security and Nutrition

Improving household food security is another common ISP objective. But, to date, little research has been conducted on this topic (see table 3B.2). The only study we know of [M21] suggests participation in Malawi's MFISP raises per capita nonfood spending by 125 percent on average, other factors constant, but has no effects on food consumption, health-related spending, or dietary diversity. But there is some evidence that MFISP participation increases weight-for-height among preschool-aged children [M21].[43]

Though not technically an ISP, the EFSP also has mixed and limited empirical results on this question. Participation in public works and the OFSP is associated with 0.4 fewer months of food security over two years, but participants acquire 230 (10 percent) more calories per week than nonparticipants on average, all else equal [E1]. Given this topic's dearth of research, it is difficult to know if these results are generalizable.

Household-Level Effects on Incomes, Poverty, and Assets

Several econometric studies have estimated the effects of ISPs on income, poverty, and asset wealth at the household level (see table 3B.2). Results for Kenya's NAAIAP and Zambia's ZFISP suggest that while these ISPs reduce poverty severity by several percentage points, the programs do not reduce poverty incidence [K3, Z4, Z13]. All else equal, the programs' effects on the income of the poor, on average, are not large enough to move them above the poverty line. The lack of an ISP effect on household-level poverty incidence in Zambia could be due to elite capture of a disproportionate share of ISP benefits.[44]

The results for Malawi, again, are mixed: [M10] suggests that receiving the full MFISP input pack raises per capita incomes by 8.2 percent, but [M17] finds no significant MFISP fertilizer effects on household assets, total income, or off-farm income. Overall, the literature suggests that ISPs have the potential to raise income and reduce poverty severity at the household level, but are less likely to decrease the probability that households fall below the poverty line.[45]

Household-Level Effects on Soil Fertility Management Practices, Fallow Land, and Forests

In addition to the oft-stated objectives, ISPs could have spillover effects on other outcomes, such as using other soil fertility management practices. Experimental evidence from Mali suggests that access to free fertilizer induces households to increase fertilizer use but also to reoptimize their use of other inputs, such as herbicide or labor (Beaman et al. 2013).

Some studies have examined how much ISPs encourage (or discourage) the use of other soil fertility management practices. [G1] finds no evidence that Ghana's ISP has an impact on soil and water management after controlling for hired and household labor availability and other factors. Both [M13, M15] and [Z3] find that ISP fertilizer does not affect Malawi and Zambian smallholders' organic manure use. But while [Z14] finds some evidence that the ZFISP reduces intercropping in Zambia, [M13] finds no such effects for MFISP. [Z14] also finds that the ZFISP discourages crop rotation and encourages continually planting maize on the same plot. Results from Zambia also suggest that the ZFISP discourages fallowing [Z3, Z14]. High soil acidity and little soil organic matter on many Zambian smallholders' maize fields reduce fertilizer use efficiency but intercropping, crop rotation, and fallowing can improve soil quality. By incentivizing maize monocropping within seasons and by disincentivizing fallowing, the ZFISP may be undermining the effectiveness of inorganic fertilizer distributed through the program. Thus, while ISPs aim to increase soil fertility, there may be unintended negative consequences of the programs on using inputs or management practices complementary to inorganic fertilizer use.

Turning to the effects of ISPs on forest cover and trees (naturally occurring and planted), the empirical record is again mixed. All studies to date on this topic in Sub-Saharan Africa have been for Malawi. [M9] finds that receiving a full set of MFISP coupons (fertilizer plus maize seed) reduces pressure on surrounding forests. Based on a different data set, [M13] finds that MFISP increases both planting new trees and cutting down naturally occurring trees. Key takeaways are that ISPs can alter incentives for various

soil fertility and land management practices and much remains to be learned about how ISPs affect adoption of crops and inputs beyond those being promoted.

The Dynamic or Enduring Effects of ISPs on Farm Households

The studies discussed in the previous sections focus on the contemporaneous effects of ISPs. But a common argument made for ISPs is that by stimulating learning about the inputs, by helping farm households break out of poverty traps, or by building private sector input markets and increasing demand for inputs, ISPs could kick-start dynamic growth processes and have effects beyond their current year (Chirwa and Dorward 2013). Phosphorus in the fertilizers distributed through many ISPs can also continue to have effects on crop productivity for several years after its initial application. Whether there is empirical evidence of dynamic or enduring effects of ISPs depends on the outcome variable and the context.

In Malawi, the evidence suggests the absence of enduring or lagged effects of the MFISP on household maize production, assets, and income (total, farm, and off-farm) [M17, M28], but possible lagged crowding in effects on demand for commercial fertilizer after an initial crowding out period [M28]. In Mozambique, where far fewer households use fertilizer than in Malawi (and potential for learning effects may be greater), Carter, Laajaj, and Yang's (2014) randomized control trial results for a pilot ISP suggest substantial, positive enduring effects on many but not all the outcome variables considered. Some of these dynamic effects in Mozambique might be due to concurrent efforts by IFDC to strengthen agro-dealer networks and fertilizer supply as part of the pilot program. Thus depending on the outcome variable and context, ISPs may or may not have lasting, positive effects on farm households beyond the year of receipt.

Market-Level and General Equilibrium Effects of ISPs

As demonstrated earlier, ISPs have had positive (though in several cases, relatively small) effects on household fertilizer use, crop yields, production, and incomes. ISPs' effects on these outcomes at more aggregate or national levels, and ISPs' partial- and general equilibrium effects on food prices and labor markets may differ. We examine the literature on these issues in this subsection, and conclude with a discussion of the empirical evidence on how much ISPs affect voting patterns and election results. See table 3B.3 for a summary of the aggregate level effects of ISPs.

Table 3B.3 Empirical Findings on the Aggregate-Level Effects of ISPs

Country	Empirical findings
Fertilizer use (accounting for crowding out and diversion)	
Ethiopia	—
Ghana	—
Kenya	1 MT increase in subsidized fertilizer (NCPB or NAAIAP) raises national fertilizer use by 0.57 MT with no diversion, and 0.51 (0.38) MT with 10 percent (33 percent) diversion, c.p. [K2, K4]
Malawi	With 33 percent diversion, 1 MT increase in MFISP fertilizer raises national fertilizer use by 0.55 MT, c.p. [M1, M2]
Nigeria	—
Tanzania	—
Zambia	With 33 percent diversion, 1 MT increase in ZFISP fertilizer raises national fertilizer use by 0.58 MT, c.p. [Z1, Z15, Z16]
Crop production, food self-sufficiency	
Ethiopia	—
Ghana	—
Kenya	—
Malawi	Based on CGE model, 2006/07 MFISP raised national maize production by 174,300–307,300 MT (9–15 percent) and net maize exports by 44,900–122,500 MT (132–188 percent) [M22]
	Based on partial equilibrium model of the informal rural economy, [M27] estimate MFISP raises maize production by 11–23 percent per year across all HHs, and 31–39 percent among target (poor) HHs
	Based on an administrative area-level cross sectional data set (2008/09), a 1 percent increase in HHs receiving MFISP raises administrative area maize yields by approximately 0.2 percent, c.p. [M26]
Nigeria	—
Tanzania	US$300 million in NAIVS cost produced 2.5 million added tons of maize and rice over the program's course [T4]
Zambia	—
Food price levels	
Ethiopia	—
Ghana	—
Kenya	—
Malawi	Doubling MFISP scale (fertilizer quantity distributed) reduces retail maize prices by 1–3 percent [M4]
	Based on CGE model, 2006/07 MFISP reduced real maize prices by 2–4 percent, and reduced food prices by 2–3 percent [M22]
	Based on partial equilibrium model of the informal rural economy, [M27] estimate that MFISP raises mean preharvest (postharvest) wage-to-maize price ratios by 5–26 percent (32–73 percent) through both wage-increasing and maize price-reducing effects
Nigeria	Increase in scale of FMSP in an LGA (that is, increase in mean kg per HH or share of HHs receiving subsidized fertilizer) has no statistical significance or very weak negative effect on local rice, sorghum, and maize price interseason growth rates, c.p. [N6]
Tanzania	—
Zambia	Doubling scale of fertilizer ZFISP (quantity distributed) reduces retail maize prices by 2–3 percent [Z17]

(continued next page)

Table 3B.3 (continued)

Country	Empirical findings
Agricultural labor wage rates and supply and demand	
Ethiopia	No evidence of any significant positive correlation between EFSP participation and entering labor markets, agricultural or otherwise [E1]
Ghana	—
Kenya	—
Malawi	*Ganyu* (short-term) labor supply: Among ganyu labor supplying smallholders HHs (all smallholder HHs), a 100 kg increase in MFISP fertilizer reduces (has no effect on) the probability of supplying ganyu labor by 2.3 p.p., and reduces the number of days supplied by 10.7 days (2.9 days), c.p.
	Ganyu labor demand: A 100 kg increase in MFISP fertilizer has no effect on the days of ganyu labor demanded (both among all HHs and ganyu-demanding HHs), but raises the probability of ganyu labor demand by 1.6 p.p. among all HHs, c.p. [M18]
	Agricultural wage rates: A 10 kg increase in the average quantity of MFISP fertilizer acquired by HHs in a community raises the median agricultural wage rate in the community by 1.4 percent, c.p. This is equivalent to an increase in average annual income of about US$1.40–US$1.86 [M18]
	Based on CGE model: 2006/07 MFISP increased the average farm wage by 4–7 p.p. (5–8 percent) [M22]
	Based on partial equilibrium model of the informal rural economy, [M27] estimate that MFISP raises mean preharvest (postharvest) wage-to-maize price ratios by 5–26 percent (32–73 percent) through both wage-increasing and maize price-reducing effects
Nigeria	—
Tanzania	—
Zambia	—
Incomes and poverty	
Ethiopia	—
Ghana	—
Kenya	—
Malawi	Based on CGE model, 2006/07 MFISP reduced the national poverty rate by 1.6–2.7 p.p., the rural poverty rate by 1.5–2.7 p.p., and the urban poverty rate by 1.5–2.9 p.p. [M22]. Slightly higher reduction in urban poverty rate due to reduction in food prices and increase in wages [M22]
	Based on partial equilibrium model of the informal rural economy, [M27] estimate real income increases as a result of MFISP of 3–11 percent per year across all HHs, and 6–31 percent among target (poor) HHs
Nigeria	—
Tanzania	—
Zambia	—
Voting patterns and election results	
Ethiopia	—
Ghana	—
Kenya	—

(continued next page)

Table 3B.3 (continued)

Country	Empirical findings
Malawi	MFISP increased support for DPP party, c.p. [M5, M6]. More specifically, [M5] find that respondents whose HH received MFISP in 2009 were 6–7 percent more likely to "feel close to" the DPP in 2010, c.p.
	[M6] find that a 1 p.p. increase in the percentage of HHs receiving MFISP raised the DPP's parliamentary electoral margin over their closest rival in the constituency by 2 percent, c.p.
Nigeria	—
Tanzania	—
Zambia	An increase in percentage of smallholder HHs receiving ZFISP, the mean kg of ZFISP fertilizer received per HH, or the total (administrative) allocation of ZFISP fertilizer to the district had no c.p. on the number or share of votes won by the incumbent in the 2006 and 2010 presidential elections [Z6]

Note: Results are average partial effects and statistically significant at the 10 percent level or lower. See annex 3C for full references for the studies cited here, and for brief overviews of the data and methods used. *Ganyu* refers to short-term rural labor relationships. CGE = computable general equilibrium; c.p. = ceteris paribus; DPP = Democratic Progressive Party; EFSP = Ethiopia Food Security Program; FMSP = Federal Market Stabilization Program; HH = head of household; ISP = input support program; LGA = local government area; MFISP = Malawi Farmer Input Support Program; NAAIAP = National Accelerated Agricultural Inputs Access Program; NAIVS = National Agricultural Inputs Voucher Scheme; NCPB = National Cereals and Produce Board; p.p. = percentage point; ZFISP = Zambia Farmer Input Support Program; — = no analyses to date.

Aggregate Fertilizer Use

Based on the micro-econometric evidence discussed, most ISPs partially crowd out demand for commercial fertilizer. But a substantial share (roughly one-third in Malawi and Zambia) of fertilizer intended for ISPs is diverted by program implementers before reaching intended beneficiaries and resold as commercial fertilizer at or near commercial prices [Z1, Z15, Z16]. Such diversion needs to be taken into account when moving from household estimates of crowding out to national estimates of the impacts of ISPs on total fertilizer use.[46] Based on diversion estimates of 33 percent, 1 MT of ISP fertilizer injected into the system raises total fertilizer use by just 0.38 MT in Kenya, 0.55 MT in Malawi, and 0.58 MT in Zambia (Carter, Laajaj, and Yang 2014; see also table 3B.3). Thus, although ISPs raise total fertilizer use, there are major inefficiencies and diversion by program implementers representing another form of elite capture of ISP benefits.

Aggregate Crop Production and Food Self-Sufficiency

Many ISPs aim to raise national crop production to achieve food self-sufficiency or increase net crop exports. The only studies that directly estimate these effects have been conducted for Malawi and take either a partial equilibrium or CGE modeling approach [M26 and M27, respectively].[47] These studies suggest increases in national maize production as a result of the

MFISP (for example, in 2006/07) of 9–23 percent (with even larger percentage increases among targeted households), and increases in net maize exports of 132–188 percent.

Food Price Levels

Though typically not stated as an explicit objective of ISPs, if the programs reduce food prices (by increasing food supply), the programs could benefit urban consumers and net food buyers, including many poor rural households. The effects of ISPs on food prices have been estimated for Malawi [M4, M22, M27], Nigeria [N6], and Zambia [Z17]. Though using different approaches, [M4, M22, Z17] suggest modest reductions in retail maize prices as a result of Malawi's MFISP and Zambia's ZFISP of about 1–4 percent. [M22] also suggests that the MFISP reduced overall food prices (that is, maize and other food items) by 2–3 percent. Though not directly comparable, [M27]'s findings suggest a decrease in the maize-to-wage price ratio as a result of the MFISP due to both reductions in maize prices and increases in wages. Only for Nigeria is there little evidence of ISP effects on food prices [N6] (see table 3B.3). Thus, the empirical evidence suggests that ISPs in Sub-Saharan Africa reduce food prices but by small amounts.

Agricultural Labor Wage Rates and Supply and Demand

ISPs could further benefit poor nonbeneficiary households—which often engage in agricultural wage labor—if the programs increase demand for such labor and thus put upward pressure on agricultural wages. Only for Malawi is there empirical evidence on the effects of ISPs on agricultural wages or supply and demand. Collectively, the results suggest that the MFISP does raise agricultural wages, but the effects vary across studies (see table 3B.3). CGE model results suggest increases in average farm wages of 5–8 percent because of the MFISP [M22], but micro-econometric estimates suggest increases of 1 percent [M18]. The MFISP also seems to result in small increases (decreases) in labor demand (supply) [M18].

Incomes and Poverty

Apart from the household-level poverty impacts discussed above, ISPs could reduce the national poverty rate and, more specifically, notoriously stubborn rural poverty rates. That said, there is little empirical evidence to examine these relationships. CGE modeling work from Malawi [M22] suggests that the 2006/07 MFISP reduced the national poverty rate by 1.6–2.7 percentage points and that poverty reductions in rural and urban areas were similar, if not slightly greater, in urban areas (see table 3B.3).

Voting Patterns and Election Results

Once established, ISPs often become entrenched features of countries' agricultural sector policies. The conventional wisdom is that scaling back ISPs is politically damaging, but establishing or scaling up ISPs is politically beneficial. But does the empirical record support these claims? Again, the answer depends on the context, both in the political dynamics and the design and implementation of the ISP. Evidence from Malawi suggests that the MFISP substantially increased support for Bingu Wa Mutharika and his Democratic Progressive Party (DPP) in the 2009 election [M5, M6]. But in Zambia, [Z6] find no evidence that the ZFISP affected the number or share of votes won by the incumbent in the 2006 and 2011 presidential elections, on average and other factors constant.

There are several reasons ISPs may have affected voting patterns in Malawi but not in Zambia. First, the run-up to the 2009 election in Malawi was unique. After being elected in 2004, President Mutharika left his former party, the United Democratic Front (UDF), and started his own party (the DPP) in 2005. His old party controlled parliament, so Mutharika needed a large-scale and highly publicized policy initiative to garner support for reelection in 2009 ([M5, M6], Chinsinga and Poulton 2014). There was no such seismic political imperative in Zambia. Second, the MFISP reaches a much larger share of Malawi smallholders than the ZFISP does in Zambia (table 3A.4). Third, the benefits of the ZFISP are much more highly concentrated in the hands of relatively better-off farmers than are the benefits of the MFISP (table 3B.3). Together, these differences in the Malawi and Zambian contexts could explain the different effects of ISPs on voting patterns in the two countries. It would be useful to test whether the MFISP played a similarly important role in elections in Malawi after 2009, when Mutharika's DPP was well established.

Annex 3C: References for Annexes 3A and 3B and Basic Information on Data Sources and Methods

Ethiopia

[E1] Gilligan, D. O., J. Hoddinott, and A. S. Taffesse. 2009. "The Impact of Ethiopia's Productive Safety Net Programme and Its Linkages." *Journal of Development Studies* 45 (10): 1684–1706. (Sample of 3,700 households representing the four regions principally served by the Productive Safety Net Programme [Tigray, Amhara, Oromiya, and Southern Nations, Nationalities, and People's Region].)

[E2] Rashid, S., N. Tefera, N. Minot, and G. Ayele. 2013. "Can Modern Input Use Be Promoted without Subsidies? An Analysis of Fertilizer in Ethiopia." *Agricultural Economics* 44 (6): 595–611. (Estimates based on 2008 Ethiopian Development Research Institute–International Food Policy Research Institute [IFPRI] household survey.)

Ghana

[G1] Vondolia, G. K., H. Eggert, and J. Stage. 2012. "Nudging Boserup? The Impact of Fertilizer Subsidies on Investment in Soil and Water Conservation." Discussion Paper 12-08, Environment for Development and Resources for the Future, Washington, DC. (Cross-sectional data from 460 rice farmers in the Afife irrigation project in Ghana's Volta region.)

[G2] Banful, A. B. 2009. "Old Problems in the New Solutions? Politically Motivated Allocation of Program Benefits and the 'New' Fertilizer Subsidies." *World Development* 39 (7): 1166–76.

[G3] Resnick, D., and D. Mather. 2015. "Agricultural Inputs Policy under Macroeconomic Uncertainty: Applying the Kaleidoscope Model to Ghana's Fertilizer Subsidy Program (2008–2015)." Draft working paper, IFPRI and Michigan State University, Washington, DC, and East Lansing, MI.

Kenya

[K1] Sheahan, M., J. Olwande, L. Kirimi, and T. S. Jayne. 2014. "Targeting of Subsidized Fertilizer under Kenya's National Accelerated Agricultural Input Access Program (NAAIAP)." Working Paper 52, Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya. (Two waves of nationwide household panel survey data; NAAIAP receipt only captured in second [2010] wave; probit models using NAAIAP receipt as of second wave as dependent variable; and head of household (HH) to village characteristics as of first [2007] wave.)

[K2] Mather, D., and T. S. Jayne. 2015. "Fertilizer Subsidies and the Role of Targeting in Crowding Out: An Assessment of Smallholder Fertilizer Demand in Kenya." Selected paper prepared for the 29th International Conference of Agricultural Economists, Milan, Italy, August 8–14. (Four waves of nationwide HH panel survey data; NAAIAP/National Cereals and Produce Board receipt captured only in fourth [2010] wave; targeting results based on correlated random effects [CRE] Tobit regressions; crowding out/total fertilizer use effects based on truncated normal hurdle model with CRE and control function [CF].)

[K3] Mason, N. M., A. Wineman, L. Kirimi, and D. Mather. 2015. "The Effects of Kenya's 'Smarter' Input Subsidy Program on Smallholder Behavior and Incomes: Do Different Quasi-Experimental Approaches Lead to the Same Conclusions?" Working Paper, Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya. (Three waves of nationwide household panel survey data; NAAIAP receipt captured only in third [2010] wave; range of impact estimates due to range of econometric approaches used—that is, difference-in-differences [DID], fixed effects [FE], propensity score weighting-DID, and propensity score matching-DID with associated Rosenbaum bounds. "Maize yield" is kilogram of maize harvested per acre planted with maize, be it mono- or intercropped. Not feasible to apportion intercropped area to constituent crops with these data.)

[K4] Jayne, T. S., D. Mather, N. M. Mason, J. Ricker-Gilbert, and E. Crawford. 2015. "Rejoinder to the Comment by Andrew Dorward and Ephraim Chirwa on Jayne, T. S, D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. 'How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments.' *Agricultural Economics* 44 (6): 687–703." *Agricultural Economics* 46 (6): 745–55.

[K5] Jayne, T. S., D. Mather, N. M. Mason, and J. Ricker-Gilbert. 2013. "How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments." *Agricultural Economics* 44 (6): 687–703. (Kenya analysis same as [K2] above.)

[K6] Ochola, R. O., and F. Nie. 2015. "Evaluating the Effects of Fertilizer Subsidy Programmes on Vulnerable Farmers in Kenya." *Journal of Agricultural Extension and Rural Development* 7 (6): 192–201. (Despite the article's title and although it focuses on NAAIAP, it does not estimate the effects of NAAIAP participation on household incomes or other outcomes; the sample includes only NAAIAP beneficiaries.)

Malawi

[M1] Jayne, T. S., D. Mather, N. M. Mason, J. Ricker-Gilbert, and E. Crawford. 2015. "Rejoinder to the Comment by Andrew Dorward and Ephraim Chirwa on Jayne, T. S, D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. 'How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments.' *Agricultural Economics* 44 (6): 687–703." *Agricultural Economics* 46 (6): 745–55.

[M2] Jayne, T. S., D. Mather, N. M. Mason, and J. Ricker-Gilbert. 2013. "How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments." *Agricultural Economics* 44 (6): 687–703. (Three waves of nationally representative HH survey data: Integrated Household Survey II [IHS2], Agricultural Input Subsidy Survey 1 [AISS1], and Agricultural Input Subsidy Survey 2 [AISS2]; truncated normal hurdle model with CRE and CF approach.)

[M3] Ricker-Gilbert, J., T. S. Jayne, and E. Chirwa. 2011. "Subsidies and Crowding Out: A Double-Hurdle Model of Fertilizer Demand in Malawi." *American Journal of Agricultural Economics* 93 (1): 26–42. (Two waves of nationally representative household survey data [IHS2 covers 2002/03 and 2003/04, and AISS1 covers 2006/07]; truncated normal hurdle model with CRE and CF approach.)

[M4] Ricker-Gilbert, J., N. M. Mason, F. A. Darko, and S. T. Tembo. 2013. "What Are the Effects of Input Subsidy Programs on Maize Prices? Evidence from Malawi and Zambia." *Agricultural Economics* 44 (6): 671–86. (Malawi analysis based on 12 years of biannual data from 72 markets in 26 districts; Arellano-Bond dynamic panel data models.)

[M5] Dionne, K. Y., and J. Horowitz. 2013. "The Political Effects of Anti-Poverty Initiatives: An Analysis of Malawi's Agricultural Input Subsidy Program." Paper presented at the Midwest Group in African Political Economy meeting, Indiana University, Bloomington, IN, October 17–18. (Data from three districts on Farm Input Subsidy Program [FISP] participation in 2009, and respondent-level panel data from 2008 and 2010 on partisan leanings, and other respondent and HH characteristics; logit models for receipt of FISP; logit, matching, and Rosenbaum bounds sensitivity analysis for effects of FISP receipt in 2009 on partisanship in 2010.)

[M6] Brazys, S., P. Heaney, and P. P. Walsh. 2015. "Fertilizer and Votes: Does Strategic Economic Policy Explain the 2009 Malawi Election?" *Electoral Studies* 39: 39–55. (Various data sources including the 2008 Malawi Welfare Monitoring Survey, the 2004/05 Malawi Integrated Household Survey, AidData, Afrobarometer Round 3 [2005], Malawi Electoral Commission, and others—please see the article for details; constituency and district-level data and two-step procedure/IV approach [district-level regressions] to correct for endogeneity of FISP to election outcomes.)

[M7] Chibwana, C., G. Shively, M. Fisher, and C. Jumbe. 2014. "Measuring the Impacts of Malawi's Farm Input Subsidy Programme." *African Journal of Agriculture and Resource Economics* 9 (2): 132–47. (Two- and three-year household panel survey data set from 375 and 176 total smallholder households,

respectively, in two districts—Kasungu and Machinga; IV approach; panel data used to create lagged variables but panel data methods not used.)

[M8] Chibwana, C., M. Fisher, and G. Shively. 2012. "Cropland Allocation Effects of Agricultural Input Subsidies in Malawi." *World Development* 40 (1): 124–33. (Same data as [M7] but used only most recent wave, 2008/09, as cross-section; multinomial logit and probit regressions for targeting; Tobit regressions for share of land devoted to various crops; two-step/IV approach.)

[M9] Chibwana, C., C. Jumbe, and G. Shively. 2012. "Agricultural Subsidies and Forest Clearing in Malawi." *Environmental Conservation* 40 (1): 60–70. (Cross-sectional data from 380 HHs near forest reserves in two districts in Malawi; two-step/IV approach with multinomial logit regression for targeting, and Tobit regression for the extent of forest clearing.)

[M10] Chirwa, T. G. 2010. "Program Evaluation of Agricultural Input Subsidies in Malawi Using Treatment Effects: Methods and Practicability Based on Propensity Scores." Munich Personal Research Papers in Economics Archive Paper 21236, Ludwig-Maximilians-Universität München, Munich, Germany. http://mpra.ub.uni-muenchen.de/21236/1/MPRA_paper_21236.pdf. (Panel data from the nationally representative IHS2 and AISS1; PSM and IV approaches; panel data methods not employed.)

[M11] Chirwa, E. W., P. M. Mvula, A. Dorward, and M. Matita. 2011. "Gender and Intra-Household Use of Fertilizers in the Malawi Farm Input Subsidy Programme." Working Paper 028, Future Agricultures Consortium, Brighton, U.K. (Cross-sectional data from the nationally representative AISS2 survey, which covers the 2008/09 agricultural season; probit regressions; no correction for endogeneity of FISP participation.)

[M12] Fisher, M., and V. Kandiwa. 2014. "Can Agricultural Input Subsidies Reduce the Gender Gap in Modern Maize Adoption? Evidence from Malawi." *Food Policy* 45 (May): 101–11. (Cross-sectional data from the nationally representative IHS3, which covers the 2008/09 agricultural season; multinomial logit for targeting analysis, and logit model for factors affecting adoption of modern maize varieties; two-step/IV approach.)

[M13] Holden, S. T., and R. Lunduka. 2010. *Too Poor to be Efficient? Impacts of the Targeted Fertilizer Subsidy Programme in Malawi on Farm Plot Level Input Use, Crop Choice, and Land Productivity*. Noragric Report 55. Ås, Norway: Department of International Environment and Development Studies, Norwegian University of Life Sciences. (Three-wave panel survey of 450 HHs (378 in balanced panel) in six districts in Malawi; random effects, fixed effects, panel probit, and bivariate probit models; IV approach also tried but authors

note that "no good instruments were available for predicting each of the input variables" [5].)

[M14] Holden, S. T., and R. W. Lunduka. 2013. "Who Benefit from Malawi's Targeted Farm Input Subsidy Program?" *Forum for Development Studies* 40 (1): 1–25. (Data same as last two waves in [M13]; ordered probit for maize market position [net buyer, autarkic, net seller], ordinary least squares [OLS] for maize production; lagged dependent variables included in regressions; panel data methods and instrumental variables not employed.)

[M15] Holden, S. T., and R. Lunduka. 2012. "Do Fertilizer Subsidies Crowd Out Organic Manures? The Case of Malawi." *Agricultural Economics* 43 (3): 303–14. (Same data as [M13]; probit and Tobit models with CRE and CF approach.)

[M16] Mason, N. M., and J. Ricker-Gilbert. 2013. "Disrupting Demand for Commercial Seed: Input Subsidies in Malawi and Zambia." *World Development* 45 (May): 75–91. (Two waves of nationally representative household panel survey data—AISSI and AISS2; Tobit models with CRE and CF.)

[M17] Ricker-Gilbert, J., and T. S. Jayne. 2011. "What Are the Enduring Effects of Fertilizer Subsidy Programs on Recipient Farm Households: Evidence from Malawi." Staff Paper 2011–09, Department of Agricultural, Food, and Resource Economics, Michigan State University, East Lansing, MI. (Three-waves of nationally representative HH panel survey data—IHS2, AISS1, AISS2; first-difference estimator and log-normal hurdle model with CRE, both with CF approach.)

[M18] Ricker-Gilbert, J., and T. S. Jayne. 2012. "Do Fertilizer Subsidies Boost Staple Crop Production and Reduce Poverty Across the Distribution of Smallholders in Africa? Quantile Regression Results from Malawi." Selected paper prepared for presentation at the International Association of Agricultural Economists Triennial Conference, Foz do Iguaçu, Brazil, August 18–24. (Same data as [M17]; quantile regression model with CRE.)

[M19] Ricker-Gilbert, J. 2014. "Wage and Employment Effects of Malawi's Fertilizer Subsidy Program." *Agricultural Economics* 45 (3): 337–53. (Same as [M17]; fixed effects and CRE Tobit regressions.)

[M20] Karamba, R. W., and P. C. Winters. 2015. "Gender and Agricultural Productivity: Implications of the Farm Input Subsidy Program in Malawi." *Agricultural Economics* 46 (3): 357–74. (Same data as [M12]; probit model for FISP participation, and OLS, propensity score weighting [PSW], and PSW with spatial fixed effects for yield effects of FISP.)

[M21] Karamba, R. W. 2013. "Input Subsidies and Their Effect on Cropland Allocation, Agricultural Productivity, and Child Nutrition: Evidence from Malawi." PhD dissertation, American University, Washington, DC. (Same data

as [M12]; probit and IV models for if used fertilizer on plot, OLS and IV for kg and kg per hectare of fertilizer applied, and crop diversity, OLS and three-stage least squares for cropland allocation decisions. OLS and IV for per capita value of food consumption, nonfood consumption, and health expenditures, dietary diversity, and weight-for-height Z-score for preschool children [6–59 months].)

[M22] Arndt, C., K. Pauw, and J. Thurlow. 2015. "The Economywide Impacts and Risks of Malawi's Farm Input Subsidy Programme." WIDER Working Paper 2014/099, United Nations University, World Institute for Development Economics Research, Helsinki, Finland. (Study of the 2006/07 FISP, which aimed to distribute 150,000 MT of fertilizer for use on maize, along with improved seed (60 percent of which was hybrid, and 40 percent of which was composite); assumed these inputs were used on 500,000 ha of land; CGE model of the Malawi economy based on 2003 Social Accounting Matrix; CGE model linked to a poverty module based on household survey data (IHS2) to estimate impacts of FISP on consumption poverty. "Observed consumption changes in the model are then applied proportionally to survey households, each with a unique consumption pattern. A post-simulation consumption value can then be calculated and compared against an absolute poverty threshold to determine if a household's poverty status has changed from the base." [5].)

[M23] Westberg, N. B. 2015. "Exchanging Fertilizer for Votes?" Working Paper 12/2015, Norwegian University of Life Sciences School of Economics and Business, Ås, Norway. (Main data sources are district-level FISP allocations from the Malawi Logistics Unit, population data from the National Statistical Office, and election data from the Sustainable Development Network Programme and Malawi Electoral Commission; six years of district-level panel data covering all 28 districts in Malawi; district-level fixed effects model of number of FISP vouchers allocated to district regressed on past election results and other controls.)

[M24] Chirwa, E. W., M. Matita, and A. Dorward. 2010. "Targeting Agricultural Input Subsidy Coupons in Malawi." Working Paper, School of Oriental and African Studies, University of London, London, U.K. (Cross-sectional data from the nationally representative AISS2 survey, which covers the 2008/09 agricultural season; probit and Tobit models for factors affecting receipt of FISP fertilizer coupons and kilograms, of subsidized fertilizer acquired, respectively.)

[M25] Holden, S. 2013. "Input Subsidies and Demand for Improved Maize: Relative Prices and Household Heterogeneity Matter!" Centre for Land Tenure Studies Working Paper 06/13, Norwegian University of Life Sciences, Ås, Norway. (Simulations based on nonseparable agricultural household models, with rural Malawi households classified into six households groups based on

region [South vs. Central], sex of the HH, and land availability ["land-poor" vs. "land-rich"]. Models calibrated to 2005/06 survey data from six districts.)

[M26] Mkwara, B., and D. Marsh. 2011. "Effects of Maize Fertilizer Subsidies on Food Security in Malawi." Working Paper in Economics 14/11, Department of Economics, University of Waikato, Hamilton, New Zealand. (Cross-sectional, nationwide administrative area data from the 2008/09 Annual National Census of Agriculture. OLS and OLS controlling for spatial autocorrelation regressions of administrative area maize yield on the percentage of HHs receiving FISP and other controls. No correction for potential endogeneity of FISP to maize yields.)

[M27] Dorward, A., and E. Chirwa. 2013. "Impacts of the Farm Input Subsidy Programme in Malawi: Informal Rural Modeling." Working Paper 067, Future Agricultures Consortium, Brighton, U.K. (Partial equilibrium model of the impacts of FISP on smallholder livelihoods in two livelihood zones for 2005/06 through 2010/11. IHS2 data used to develop household/livelihood zone classification scheme. Household livelihood models developed for Kasungu Lilongwe Plain and Shire Highlands for each household type per the classification scheme [see paper for details]; model results then aggregated by livelihood zone to obtain an "informal rural economy" model. "With subsidy" scenario modeled in two ways: (a) universal 50 kg fertilizer + 2 kg hybrid maize seed, and (b) targeted distribution of 100 kg of fertilizer + 2 kg hybrid maize seed to their "poor male-headed household" and "poor female-headed household" types. Per the authors, "An average taken across [the two scenarios] is likely to be closer to distribution patterns actually achieved. However, it should be recognized that this is likely to overestimate access by poorer households." [7].)

[M28] Kilic, T., E. Whitney, and P. Winters. 2015. "Decentralised Beneficiary Targeting in Large-Scale Development Programmes: Insights from the Malawi Farm Input Subsidy Programme." *Journal of African Economies* 24 (1): 26–56. (Cross-sectional, nationally representative HH survey data from IHS3 used to analyze the decentralized targeting of FISP during the 2009/10 agricultural season. Decomposes targeting coefficients into interdistrict, intradistrict intercommunity, and intradistrict intracommunity components. IHS3 rural HHs classified as poor [FISP eligible] or not based on annual rural household consumption per capita predicted as a function of nonmonetary explanatory variables, the IHS2 2004/05 poverty line, and a survey-to-survey imputation approach using the IHS2 data to estimate the relationship between these explanatory variables and per capita consumption. *Poor* defined in this way used as a proxy for *resource poor*, a key FISP eligibility criterion. Household assets and landholding size used as alternative proxies for *resource poor*. Probit [order probit] model for factors affecting household-level participation in FISP [number of FISP coupons received], with controls for district and agroecological zone fixed effects.)

[M29] Ricker-Gilbert, J., and T. S. Jayne. 2015. "What Are the Dynamic Effects of Fertilizer Subsidies on Commercial Fertilizer Demand and Maize Production? Panel Evidence from Malawi." Paper prepared for presentation at the symposium on "Using Smart Subsidies to Support Small Scale Farmers in Africa," International Conference of Agricultural Economists, Milan, Italy, August 18. (Four waves of panel data on 462 farm households in Malawi; panel data techniques to correct for the potential endogeneity of subsidized fertilizer to household commercial fertilizer demand and maize production.)

Nigeria

[N1] Takeshima, H., and E. Nkonya. 2014. "Government Fertilizer Subsidy and Commercial Sector Fertilizer Demand: Evidence from the Federal Market Stabilization Program in Nigeria." *Food Policy* 47 (August): 1–12. (Two different data sets analyzed: a two-year, nationwide local government area (LGA)-level pseudo-panel data set of export crop growers, and a nationally representative cross-sectional survey of agricultural households; double-hurdle version of simultaneous Tobit model with IV [and LGA-level CRE for pseudo-panel analysis] [Nelson and Olson 1978]).

[N2] Liverpool-Tasie, L. S. O. 2014c. "Fertilizer Subsidies and Private Market Participation: The Case of Kano State, Nigeria." *Agricultural Economics* 45 (6): 663–78. (Cross-sectional data set from Kano State; truncated normal hurdle model with CF approach.)

[N3] Liverpool-Tasie, L. S. O., and S. Salau. 2013. "Spillover Effects of Targeted Subsidies: An Assessment of Fertilizer and Improved Seed Use in Nigeria." Discussion Paper 01260, Development Strategy and Governance Division, IFPRI, Washington, DC. (Same data set and approach as [N2], except probit model instead of truncated normal hurdle model.)

[N4] Liverpool-Tasie, L. S. O. 2014a. "Do Vouchers Improve Government Fertilizer Distribution? Evidence from Nigeria." *Agricultural Economics* 45 (4): 393–407. (Same data as [N2] and [N3] plus cross-sectional data set from Taraba State; PSM and Rosenbaum bounds.)

[N5] Liverpool-Tasie, L. S. O. 2014b. "Farmer Groups and Input Access: When Membership Is Not Enough." *Food Policy* 46 (June): 37–49. (Same data as [N4]; generalized Tobit and lognormal hurdle models.)

[N6] Takeshima, H., and L. S. O. Liverpool-Tasie. 2015. "Fertilizer Subsidies, Political Influence and Local Food Prices in Sub-Saharan Africa: Evidence from Nigeria." *Food Policy* 54 (July): 11–24. (Enumeration area [EA] local rice, maize,

and sorghum prices for 187 EAs, and LGA-level subsidized fertilizer quantities; multiple EAs per LGA; prices measured at post-harvest and post-planting in one year; EA-level, two-season panel; three-stage least squares models for growth rate in crop price.)

[N7] Takeshima, H., E. Nkonya, and S. Deb. 2012. "Impact of Fertilizer Subsidies on the Commercial Fertilizer Sector in Nigeria: Evidence from Previous Fertilizer Subsidy Schemes." Working Paper 23, IFPRI Nigeria Strategy Support Program II, Abuja, Nigeria. (Same data as [N1], endogenous Tobit model with both data sets, and combined with CRE in analysis of the pseudo-panel data.)

Tanzania

[T1] Pan, L., and L. Christiaensen. 2012. "Who Is Vouching for the Input Voucher? Decentralized Targeting and Elite Capture in Tanzania." *World Development* 40 (8): 1619–33.

[T2] Msolla, M. M. 2014. "Effects of the Subsidy Voucher Program on Fertilizer Markets: Example from Tanzania." Paper presented at the International Fertilizer Development Center Training on Fertilizer Value Chain-Supply System Management and Servicing Farmers' Needs, Accra, Ghana, April 14–18.

[T3] Mather, D., B. Waized, D. Ndyetabula, A. Temu, I. Minde, and D. Nyange. 2015. "The Role of Relative Prices, Agro-Ecological Factors, and Household Soil and Crop Management Practices in Explaining Smallholder Profitability of Fertilizer Use on Maize in Tanzania." Michigan State University, East Lansing, MI.

[T4] World Bank. 2014. *Tanzania Public Expenditure Review: National Agricultural Input Voucher Scheme (NAIVS). Strengthening National Comprehensive Agricultural Public Expenditure in Sub-Saharan Africa*. Washington, DC: World Bank. www.worldbank.org/afr/agperprogram.

Zambia

[Z1] Mason, N. M., and T. S. Jayne. 2015. "Fertilizer Subsidies and Smallholder Commercial Fertilizer Purchases: Crowding Out, Leakage and Policy Implications for Zambia." *Journal of Agricultural Economics* 64 (3): 558–82. (Three waves of nationally representative household panel survey data; Tobit and truncated normal hurdle models with CRE and CF approach.)

[Z2] Mason, N. M., and J. Ricker-Gilbert. 2013. "Disrupting Demand for Commercial Seed: Input Subsidies in Malawi and Zambia." *World Development* 45 (May): 75–91. (Two waves of nationally representative household panel survey data; Tobit models with CRE and CF.)

[Z3] Mason, N. M., T. S. Jayne, and R. Mofya-Mukuka. 2013. "Zambia's Input Subsidy Programs." *Agricultural Economics* 44 (6): 613–28. (Most results based on three waves of nationally representative household panel survey data; targeting results also reported from a more recent nationally representative cross-section; various econometric models combined with CRE and CF.)

[Z4] Mason, N. M., and M. Smale. 2013. "Impacts of Subsidized Hybrid Seed on Indicators of Economic Well-Being Among Smallholder Maize Growers in Zambia." *Agricultural Economics* 44 (6): 659–70. (Two waves of nationally representative household panel survey data; various econometric models with CRE and CF.)

[Z5] Mason, N. M., T. S. Jayne, and R. J. Myers. 2015. "Smallholder Supply Response to Marketing Board Activities in a Dual Channel Marketing System: The Case of Zambia." *Journal of Agricultural Economics* 66 (1): 36–65. (Three waves of nationally representative household panel survey data; various econometric models with CRE and CF.)

[Z6] Mason, N. M., T. S. Jayne, and N. van de Walle. 2013. "Fertilizer Subsidies and Voting Patterns: Political Economy Dimensions of Input Subsidy Programs." Selected paper presented at the Agricultural and Applied Economics Association's (AAEA) and Canadian Agricultural Economics Society Joint Annual Meeting, Washington, DC, August 4–6. (Three waves of nationally representative household panel survey data and Tobit models with CRE for targeting analysis; two waves of district-level panel data and fractional response models with CRE and CF for impacts of input subsidy program on voting patterns.)

[Z7] Xu, Z., W. J. Burke, T. S. Jayne, and J. Govereh. 2009. "Do Input Subsidy Programs 'Crowd In' or 'Crowd Out' Commercial Market Development? Modeling Fertilizer Demand in a Two-Channel Marketing System." *Agricultural Economics* 40 (1): 79–94. (Two waves of nationally representative household panel survey data with truncated normal hurdle models and CRE.)

[Z8] Zulu, P., T. Kalinda, and G. Tembo. 2014. "Effects of the Maize Input Subsidy Program on Groundnuts Production in Zambia." *Journal of Agricultural Science* 6 (7): 253–64. (Three waves of nationally representative household panel survey data; truncated normal hurdle model with CRE and CF.)

[Z9] Sianjase, A., and V. Seshamani. 2013. "Impacts of Farmer Inputs Support Program on Beneficiaries in Gwembe District in Zambia." *Journal of*

Environmental Issues and Agriculture in Developing Countries 50 (1): 40–50. (Four waves of panel data from Gwembe District; quantile regression with CRE.)

[Z10] Smale, M., E. Birol, and D. Asare-Marfo. 2014. "Smallholder Demand for Maize Hybrids in Zambia: How Far Do Seed Subsidies Reach?" *Journal of Agricultural Economics* 65 (2): 349–67. (Cross-sectional data from Central, Copperbelt, Eastern, Lusaka, Northern, and Southern provinces; IV and CF approaches.)

[Z11] Namonje-Kapembwa, T., T. S. Jayne, and R. Black. 2015. "Does Late Delivery of Subsidized Fertilizer Affect Smallholder Maize Productivity and Production?" Selected paper presented at the Agricultural and Applied Economics Association and Western Agricultural Economics Association Annual Meeting, San Francisco, CA, July 26–28. (Nationally representative cross-section; stochastic frontier model with CF.)

[Z12] Goeb, J. 2011. "Impacts of Government Maize Supports on Smallholder Cotton Production in Zambia." Master's Thesis, Michigan State University, Lansing, MI. (Three waves of nationally representative household panel survey data and two waves of enumeration area-level panel data; CRE Tobit and truncated normal hurdle models.)

[Z13] Mason, N. M., and S. T. Tembo. 2015. "Do Input Subsidy Programs Raise Incomes and Reduce Poverty among Smallholder Farm Households? Evidence from Zambia." Working Paper 92, Indaba Agricultural Policy Research Institute, Lusaka, Zambia. (Two waves of nationally representative household panel survey data; various econometric models with CRE and CF.)

[Z14] Levine, N. K. 2015. "Do Input Subsidies Crowd In or Crowd Out Other Soil Fertility Management Practices? Evidence from Zambia." Michigan State University, Lansing, MI. (Two waves of nationally representative household panel survey data; FE and FE-IV models.)

[Z15] Jayne, T. S., D. Mather, N. M. Mason, J. Ricker-Gilbert, and E. Crawford. 2015. "Rejoinder to the Comment by Andrew Dorward and Ephraim Chirwa on Jayne, T. S., D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. 'How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments,' *Agricultural Economics* 44 (6): 687–703." *Agricultural Economics* 46 (6): 745–55.

[Z16] Jayne, T. S., D. Mather, N. M. Mason, and J. Ricker-Gilbert. 2013. "How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments." *Agricultural Economics* 44 (6): 687–703. (Zambia analysis based on three waves of nationally representative household panel survey data; truncated normal hurdle models with CRE and CF.)

[Z17] Ricker-Gilbert, J., N. M. Mason, F. A. Darko, and S. T. Tembo. 2013. "What Are the Effects of Input Subsidy Programs on Maize Prices? Evidence from Malawi and Zambia." *Agricultural Economics* 44 (6): 671–86. (Zambia analysis based on 12 years of biannual data from 50 districts; Arellano-Bond dynamic panel data models.)

Notes

1. This chapter is based mainly on a background paper (Jayne et al. 2016).
2. As shown in table 3.1, 10 countries with largest ISPs spent US$1.02 billion in 2014.
3. The Government of Ethiopia officially states that it does not have an input subsidy program, yet fertilizer is typically made available to farmers at prices roughly 20–25 percent lower than the price at which commercial distributors sell fertilizer in other countries of the region. Instead of using targeted input vouchers, the Ethiopian government has been promoting fertilizer use through subsidizing the operations of farmers' organizations.
4. See Johnston and Kilby (1975), Mellor (1976), Lipton (2006), and Christiaensen, Demery, and Kuhl (2010) for Africa and worldwide evidence.
5. In many cases, the objectives of on-farm research trials are not to estimate the response rates that farmers are actually getting on their own fields, but to demonstrate the differences in yield or NUE that could be achieved if specific management practices or soil-augmenting investments were made. For these reasons, we believe that NUE estimates derived from researcher-managed trials are generally inappropriate for use in studies estimating the impacts of nationwide input subsidy programs.
6. Irrigated cereal fields in Pakistan, Bangladesh, and India received 43 percent, 84 percent, and 186 percent more fertilizer nutrient per hectare than corresponding nonirrigated fields, respectively (see Rashid et al. 2013).
7. Much of the information on soils in this report is prevalent throughout agronomic literature. Unless otherwise specified, the discussion summarized here and further details can be found in Jones et al. (2013). Also see Burke et al. (2015).
8. Related measurements are organic carbon content or soil carbon content. These measures are highly correlated, and can effectively be thought of as rebased measures of each other.
9. The process of soil nutrient depletion may partially explain why Yanggen et al.'s (1998) crop response rates from the 1980s and early 1990s are generally higher than those recorded recently even in spite of an increased proportion of cereal area under improved varieties.
10. See annex 3A for a summary of ISP implementation modalities in selected African countries.
11. For evidence of this, see Lunduka, Ricker-Gilbert, and Fisher (2013).
12. This figure excludes South Africa because of its fundamentally different agricultural system.

13. Sources in the fertilizer industry in Nigeria provide an illustrative example that has been repeated by other fertilizer sources in other countries: government officials and a chosen firm may agree that the firm will invoice the government for US$800 per ton even though the actual costs associated with delivering the fertilizer to inland markets is only US$600, an excess of US$200 per ton over the landed cost of importing fertilizer. The treasury pays the firm US$700, allowing it to earn monopoly profits of US$100 over its costs plus normal profits, while the party receives US$100 per ton imported to finance its political campaigns or other off-the-books expenses.
14. See, for example, the widely divergent findings of Ricker-Gilbert, Jayne, and Chirwa (2011) on the one hand, and Arndt, Pauw, and Thurlow (2015) on the other regarding the Malawi Farm Input Subsidy Program.
15. Muraoka (2015) links rural electrification to improved livestock breeding and increased availability and application rates of organic matter on crops.
16. Promoting local community awareness campaigns to develop and implement strategies to prevent bush fires that are a major contributor to the current low levels of soil organic matter in parts of Africa will also be important. Community-level strategies in Northern Ghana, for instance, have been successful at enforcing rules to reduce rates of bush fire.
17. See annexes 3A and 3B for overviews of Burundi's and Rwanda's ISPs, respectively. For information on programs not covered in this study, see Wanzala-Mlobela, Fuentes, and Mkumbwa (2013) for Burkina Faso and Senegal; Druilhe and Barreiro-Hurlé (2012) for Burkina Faso, Mali, and Senegal; Fuentes, Bumb, and Johnson (2012) for Mali and Senegal; and Chirwa and Dorward (2013) for Mali and Senegal.
18. Malawi implemented various fertilizer subsidy programs in most years since its independence, but through the 1990s these were generally small. The Zambian government initiated various fertilizer-on-credit schemes for farmers in several years during the 1990s, with fertilizer obtained through the program sold at or near market prices. But default rates on the fertilizer loans were high (for example, 35 percent in 1999/2000), so a large percentage of program participants received the fertilizer at an implicit subsidy rate of approximately 90 percent, having paid only the 10 percent down payment for the fertilizer (Mason, Jayne, and van de Walle 2013; ZMACO, Agricultural Consultative Forum, and FSRP 2002).
19. Kenya actually started distributing subsidized fertilizer through its National Cereals and Produce Board in 2001, but the quantities were small (Mather and Jayne 2015; NCPB 2013). We use 2007 to mark the return of major ISPs to Kenya as this is the year in which it first implemented a large-scale targeted ISP, the National Accelerated Agricultural Inputs Access Program. Both programs are discussed further below. Also, as noted in Jayne and Rashid (2013), though the Ethiopian government subsidizes the retail price of fertilizer in various ways, it does not refer to this as a fertilizer subsidy program.
20. See also Heineken's website, heinekencompany.com/media/media-releases/press-releases/2015/01/1887644.
21. Key features of the Ghana Fertilizer Subsidy Program are discussed here, but for a more thorough review, please see Resnick and Mather (2015).
22. There was also a subsidized credit component to NAAIAP called Kilimo Biashara, which targeted credit-constrained farmers who were relatively better off and

ineligible for Kilimo Plus. Throughout the remainder of the discussion we use the term NAAIAP to refer to the Kilimo Plus part of the program.

23. These are the only years for which data are publicly available.
24. See Levy (2005) and Harrigan (2008) for further details on the Starter Pack.
25. According to Harrigan (2008, 245), "These objections [to the Starter Pack] coincided with an evolution of donor food security policies toward a more holistic livelihoods approach as well as an elevation of the social safety net programme in Malawi. Hence, donors were willing to endorse a scaled down free inputs programme and to recast it in the light, not of a production enhancing technological transfer, but as one of many targeted social safety nets, albeit not necessarily the most effective."
26. See Levy (2005) for a discussion of the other key differences between the 2004/05 program and previous years.
27. Maize seed quantities have varied over time. For example, in the early years of the program, seed coupons were for 2 kg of hybrid seed or 4–5 kg of OPV seed (Lunduka, Ricker-Gilbert, and Fisher 2013).
28. As discussed in Dorward and Chirwa (2011), in the early years of the program MFISP included maize and tobacco fertilizers and OPV maize seed (but no hybrid or legume seed). Hybrid maize seed was added in 2006/07; legume seed as well as cotton seed and chemicals were added in 2007/08; and fertilizers for tea and coffee, and storage chemicals for maize were added in 2008/09. Tobacco, cotton, tea, and coffee inputs were subsequently phased out. See Dorward and Chirwa (2011) for a summary of other program changes from 2006/07 through 2008/09.
29. In 2005/06, both fertilizer and seed vouchers had to be redeemed at ADMARC and SFFRFM outlets. In 2006/07 and 2007/08, seed vouchers were redeemable at private seed retailers while fertilizer vouchers were redeemable at private fertilizer retailers and ADMARC/SFFRFM. But since 2008/09, fertilizer vouchers are only redeemable at ADMARC/SFFRFM (Dorward and Chirwa 2011; Logistics Unit 2015). Government selects, through a tender process, companies to import and deliver fertilizer to SFFRFM and ADMARC locations (Wanzala-Mlobela, Fuentes, and Mkumbwa 2013).
30. See Liverpool-Tasie and Takeshima (2013) for a summary of Nigeria's ISPs from the 1940s to 2013.
31. Note that the e-wallet system is different from the e-vouchers piloted to date in Malawi and Zambia. The latter are electronic on the agro-dealer end but paper scratch cards (similar to cellphone talk time scratch cards) on the farmer end.
32. Nigeria Federal Ministry of Agriculture and Rural Development (NFMARD)'s website, (accessed July 2015), http://www.fmard.gov.ng/Growth-Enhancement-Scheme.
33. See IFDC (2013) for a discussion of other challenges with GES in 2013.
34. Camps are the most disaggregated spatial unit in ZMAL's system.
35. Preparations are underway to pilot an electronic voucher system for the ZFISP in 2015/16 in 13 districts.
36. H. P. Melby, personal communication with authors, February 2015.
37. This relationship has also been used to study the effects of ISP improved maize seed on total improved maize seed demand (Mason and Ricker-Gilbert 2013; [Z2, M16]).

38. In addition, subsidized fertilizer acquired through the Kano State voucher pilot program, which did not distribute subsidized seed, had positive spillover effects on the probability that households used improved maize or rice seed [N3]. No such cross-input effects have been found for Malawi and Zambia, whose ISPs distribute both subsidized fertilizer and improved maize seed [M16, Z2].
39. [Z1] revisits fertilizer crowding out in Zambia using an additional wave of panel data beyond the two waves used by [Z7] and with additional corrections for endogeneity.
40. Note that private sector activity can be either commercial or noncommercial, where firms act as distribution agents for government subsidy programs. Hence it is possible that an ISP program could attract new private sector investment in input distribution at the same time that it crowds out commercial fertilizer sales to farmers.
41. Not only is the evidence base thin on yield effects, but there has also been virtually no research done on the effects of ISPs on labor productivity or total factor productivity.
42. Receipt of 100 kg of fertilizer and 10 kg of improved maize seed if a household obtains a full input pack.
43. Research on the effects of Zambia's ZFISP on household food security and children's nutritional status is underway but results are not yet available. The study by Ward and Santos (2010) has only been released in draft form and explicitly states that the results should not be cited.
44. Poverty severity is equal to zero for households with income at or above the poverty line, and equal to the squared proportion difference between household income and the poverty line for households with incomes below the poverty line (Foster, Greer, and Thorbecke 1984).
45. See also Awotide et al. (2013) and Carter, Laajaj, and Yang (2014) for randomized controlled trial (RCT) based estimates of the income and poverty effects of a small certified rice seed voucher pilot program in Nigeria and the income (and other) effects of a government ISP pilot program in Mozambique, respectively. Unlike the above studies for Kenya and Zambia, Awotide et al. (2013) find that participation in the seed voucher pilot program in Nigeria does reduce the probability of household income falling below the poverty line.
46. We contend that failure to take account of diversion of program fertilizer, as in Mason and Jayne (2013) and Jayne et al. (2013, 2015), is one reason for the divergence in conclusions between these studies and that of Arndt, Pauw, and Thurlow (2015). When Arndt, Pauw, and Thurlow (2015) do take account of crowding out (not diversion), their assessment of the Malawi program becomes less favorable, but these factors were not part of their baseline results on which their main conclusions rest.
47. [Z15 and Z16] also estimate the effects of ISPs on national maize production for Kenya, Malawi, and Zambia but do so indirectly by multiplying the total ISP fertilizer injected into the system by the estimated changes in total fertilizer use per the previous subsection, and further multiplying this quantity by the country-specific estimated maize yield response to fertilizer.

References

AGRA (Alliance for a Green Revolution in Africa). 2009. *Developing Rural Agricultural Input Supply Systems for Farmers in Africa.* Nairobi, Kenya: AGRA.

Anderson, J., J. Dillon, and J. E. Hardaker. 1977. "Agricultural Decision Analysis." Ames, IA: Iowa State University Press.

Ariga, J. and T.S. Jayne. 2011. "Fertilizer in Kenya: Factors Driving the Increase in Usage by Smallholder Farmers." In *Yes, Africa Can: Success Stories from a Dynamic Continent,* edited by P. Chuhan-Pole and M. Angwafo. Washington, DC: World Bank.

Arndt, C., K. Pauw, and J. Thurlow. 2015. "The Economy-wide Impacts and Risks of Malawi's Farm Input Subsidy Program." *American Journal of Agricultural Economics* 98 (3): 962–80.

Awotide, B. A., A. Karimov, A. Diagne, and T. Nakelse. 2013. "The Impact of Seed Vouchers on Poverty Reduction among Smallholder Rice Farmers in Nigeria." *Agricultural Economics* 44 (6): 647–58.

Banful, A. B. 2009. "Old Problems in the New Solutions? Politically Motivated Allocation of Program Benefits and the 'New' Fertilizer Subsidies." *World Development* 39 (7): 1166–76.

Bates, R.H. 1987. *Essays on the Political Economy of Rural Africa.* Berkeley, CA: University of California Press.

Bationo, A., C. B. Christianson, W. E. Baethgen, and A. U. Mokwunye. 1992. "A Farm-Level Level Evaluation of Nitrogen and Phosphorus Fertilizer Use and Planting Density for Pearl Millet Production in Niger." *Fertilizer Research* 31 (2): 175–84.

Beaman, L., D. Karlan, B. Thuysbaert, and C. R. Udry. 2013. "Profitability of Fertilizer: Experimental Evidence from Female Rice Farmers in Mali." Working Paper 18878, NBER, Cambridge, MA.

Bigsten, A., and A. Shimeles. 2007. "Can Africa Reduce Poverty by Half by 2015?" *Development Policy Review* 25 (2): 147–166.

Brazys, S., P. Heaney, and P. P. Walsh. 2015. "Fertilizer and Votes: Does Strategic Economic Policy Explain the 2009 Malawi Election?" *Electoral Studies* 39: 39–55.

Burke, W. J. 2012. "Determinants of Maize Yield Response to Fertilizer Application in Zambia: Implications for Strategies to Promote Smallholder Productivity." PhD dissertation, Michigan State University, East Lansing, MI.

Burke, W. J., E. Frossard, S. Kabwe, and T. S. Jayne. 2015. "Understanding Fertilizer Effectiveness and Adoption in Zambia." Working Paper, Indaba Agricultural Policy Research Institute, Lusaka, Zambia.

Carter, M. R., R. Laajaj, and D. Yang. 2014. "Subsidies and the Persistence of Technology Adoption: Field Experimental Evidence from Mozambique." Working Paper 20465, NBER, Cambridge, MA.

Chibwana, C., M. Fisher, and G. Shively. 2012. "Cropland Allocation Effects of Agricultural Input Subsidies in Malawi." *World Development* 40 (1): 124–33.

Chibwana, C., C. Jumbe, and G. Shively. 2012. "Agricultural Subsidies and Forest Clearing in Malawi." *Environmental Conservation* 40 (1): 60–70.

Chibwana, C., G. Shively, M. Fisher, and C. Jumbe. 2014. "Measuring the Impacts of Malawi's Farm Input Subsidy Programme." *African Journal of Agriculture and Resource Economics* 9 (2): 132–47.

Chikowo, R., S. Zingore, S. Snapp, and A. Johnston. 2014. "Farm Typologies, Soil Fertility Variability and Nutrient Management in Smallholder Farming in Sub-Saharan Africa." *Nutrient Cycling in Agroecosystems* 100 (1): 1–18.

Chinsinga, B., and C. Poulton. 2014. "Beyond Technocratic Debates: The Significance and Transience of Political Incentives in the Malawi Farm Input Subsidy Programme." *Development Policy Review* 32 (S2): 123–50.

Chirwa, E., and A. Dorward. 2013. *Agricultural Input Subsidies: The Recent Malawi Experience*. Oxford, U.K.: Oxford University Press.

Chirwa, E. W., M. Matita, and A. Dorward. 2010. "Targeting Agricultural Input Subsidy Coupons in Malawi." Working Paper, School of Oriental and African Studies, University of London, London, U.K.

Chirwa, E. W., P. M. Mvula, A. Dorward, and M. Matita. 2011. "Gender and Intra-Household Use of Fertilizers in the Malawi Farm Input Subsidy Programme." Working Paper 028, Future Agricultures Consortium, Brighton, U.K.

Chirwa, T. G. 2010. "Program Evaluation of Agricultural Input Subsidies in Malawi Using Treatment Effects: Methods and Practicability Based on Propensity Scores." Munich Personal Research Papers in Economics Archive Paper 21236, Ludwig-Maximilians-Universität München, Munich, Germany. http://mpra.ub.uni-muenchen.de/21236/1/MPRA_paper_21236.pdf.

Christiaensen, L., L. Demery, and J. Kuhl. 2010. "The (Evolving) Role of Agriculture in Poverty Reduction." Working Paper 2010/36, United Nations University, World Institute for Development Economics Research, Helsinki, Finland.

Dionne, K. Y., and J. Horowitz. 2013. "The Political Effects of Anti-Poverty Initiatives: An Analysis of Malawi's Agricultural Input Subsidy Program." Paper presented at the Midwest Group in African Political Economy meeting, Indiana University, Bloomington, IN, October 17–18.

Dorward, A., and E. Chirwa. 2011. "The Malawi Agricultural Input Subsidy Programme: 2005/2006 to 2008/2009." *International Journal of Agriculture Sustainability* 16: 232–47.

———. 2013. "Impacts of the Farm Input Subsidy Programme in Malawi: Informal Rural Modeling." Working Paper 067, Future Agricultures Consortium, Brighton, U.K.

Dorward, A., E. Chirwa, V. Kelly, T. S. Jayne, and R. Slater. 2008. *Evaluation of the 2006/07 Agricultural Input Subsidy Programme, Malawi*. Lilongwe, Malawi: Ministry of Agriculture and Food Security.

Dorward, A., P. Hazell, and C. Poulton. 2008. "Rethinking Agricultural Input Subsidies in Poor Rural Economies." Policy Brief, Future Agricultures Consortium at the Institute of Development Studies at the University of Sussex, Brighton, U.K.

Drechsel, P., L. Gyiele, D. Kunze, and O. Cofie. 2001. "Population Density, Soil Nutrient Depletion, and Economic Growth in Sub-Saharan Africa." *Ecological Economics* 38 (2): 251–58.

Druilhe, Z., and J. Barreiro-Hurlé. 2012. "Fertilizer Subsidies in Sub-Saharan Africa." ESA Working Paper 12-04, Agricultural Development Economics Division, FAO, Rome, Italy.

Duflo, E., M. Kremer, J. Robinson. 2008. "How High Are Rates of Return to Fertilizer? Evidence from Field Experiments in Kenya." *American Economic Review: Papers and Proceedings* 98 (2): 482–88.

Dugger, C. 2007. "Ending Famine, Simply by Ignoring Experts." *New York Times*, 2 December.

EIU (Economist Intelligence Unit). 2008. *Lifting African and Asian Farmers Out of Poverty: Assessing the Investment Needs*. Research Report. Seattle, WA: Bill and Melinda Gates Foundation.

Fan, S., A. Gulati, and S. Thorat. 2008. "Investment, Subsidies, and Pro-poor Growth in Rural India." *Agricultural Economics* 39 (2): 163–70.

FAO (Food and Agriculture Organization). 1975. *Planning and Organization of Fertilizer Use Development in Africa*. Rome, Italy: FAO.

———. Monitoring African Food and Agricultural Policies (MAFAP) database, Rome, Italy (accessed December 10, 2015), http://www.fao.org/in-action/mafap/database/en/.

Fisher, M., and V. Kandiwa. 2014. "Can Agricultural Input Subsidies Reduce the Gender Gap in Modern Maize Adoption? Evidence from Malawi." *Food Policy* 45 (May): 101–11.

Foster, J., J. Greer, and E. Thorbecke. 1984. "A Class of Decomposable Poverty Measures." *Econometrica* 52 (3): 761–66.

Fuentes, P. A., B. L. Bumb, and M. Johnson. 2012. *Improving Fertilizer Markets in West Africa: The Fertilizer Supply Chain in Mali*. Muscle Shoals, AL: IFDC and IFPRI. http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=E87A6046004F1F492018DA0A40CD45E5?doi=10.1.1.590.1554&rep=rep1&type=pdf.

Gautam, M. 2015. "Agricultural Subsidies: Resurging Interest in a Perennial Debate." Keynote address at the 74th Annual Conference of Indian Society of Agricultural Economics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India, December 18.

Giller, K., E. Rowe, N. de Ridder, H. van Keulen. 2006. "Resource Use Dynamics and Interactions in the Tropics: Scaling Up in Space and Time." *Agricultural Systems* 88: 8–27.

Gilligan, D. O., J. Hoddinott, and A. S. Taffesse. 2009. "The Impact of Ethiopia's Productive Safety Net Programme and Its Linkages." *Journal of Development Studies* 45 (10): 1684–1706.

Goeb, J. 2011. "Impacts of Government Maize Supports on Smallholder Cotton Production in Zambia." Master's Thesis, Michigan State University, Lansing, MI.

Harrigan, J. 2008. "Food Insecurity, Poverty and the Malawian Starter Pack: Fresh Start or False Start?" *Food Policy* 33 (3): 237–49.

Hoddinott, J., G. Berhane, D. Gilligan, N. Kumar, and A. Seyoum Taffesse. 2012. "The Impact of Ethiopia's Productive Safety Net Programme and Related Transfers on Agricultural Productivity." *Journal of African Economies* 21 (5): 761–86. http://doi.org/10.1093/jae/ejs023.

Holden, S. 2013. "Input Subsidies and Demand for Improved Maize: Relative Prices and Household Heterogeneity Matter!" Centre for Land Tenure Studies Working Paper 06/13, Norwegian University of Life Sciences, Ås, Norway.

Holden, S. T., and R. Lunduka. 2010. *Too Poor to be Efficient? Impacts of the Targeted Fertilizer Subsidy Programme in Malawi on Farm Plot Level Input Use, Crop Choice, and Land Productivity*. Noragric Report 55. Ås, Norway: Department of International Environment and Development Studies, Norwegian University of Life Sciences.

———. 2012. "Do Fertilizer Subsidies Crowd Out Organic Manures? The Case of Malawi." *Agricultural Economics* 43 (3): 303–14.

———. 2013. "Who Benefit from Malawi's Targeted Farm Input Subsidy Program?" *Forum for Development Studies* 40 (1): 1–25.

IFDC (International Fertilizer Development Center). 2013. *Growth Enhancement Support Scheme 2013: Lessons Learned.* Abuja, Nigeria. Muscle Shoals, AL: IFDC.

———. 2014. "GES-TAP (Growth Enhancement Support Touch-and-Pay) Final Report." Muscle Shoals, AL: IFDC.

Jacoby, H. 2015. "Smart Subsidy? Welfare and Distributional Consequences of Malawi's FISP." Background paper for this study, World Bank, Washington, DC.

Jayne, T. S., J. Govereh, M. Wanzala-Mlobela, and M. Demeke. 2003. "Fertilizer Market Development: A Comparative Analysis of Ethiopia, Kenya, and Zambia." *Food Policy* 28 (4): 293–316.

Jayne, T. S., N. M. Mason, W. J. Burke, and J. Ariga. 2016. "Agricultural Input Subsidy Programs in Africa: An Assessment of Recent Evidence." International Development Working Paper 145, Michigan State University, East Lansing, MI.

Jayne, T. S., D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. "How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments." *Agricultural Economics* 44 (6): 687–703.

Jayne, T. S., D. Mather, N. M. Mason, J. Ricker-Gilbert, and E. Crawford. 2015. "Rejoinder to the Comment by Andrew Dorward and Ephraim Chirwa on Jayne, T. S., D. Mather, N. Mason, and J. Ricker-Gilbert. 2013. 'How Do Fertilizer Subsidy Programs Affect Total Fertilizer Use in Sub-Saharan Africa? Crowding Out, Diversion, and Benefit/Cost Assessments.' *Agricultural Economics* 44 (6): 687–703." *Agricultural Economics* 46 (6): 745–55.

Jayne, T. S., and S. Rashid. 2013. "Input Subsidy Programmes in Sub-Saharan Africa: A Synthesis of Recent Evidence." *Agricultural Economics* 44 (6): 547–62.

Jebuni, C., and W. Seini. 1992. "Agricultural Input Policies under Structural Adjustment: Their Distributional Implications." Cornell Food and Nutrition Policy Program Working Paper 31, Ithaca, NY.

Johnston, B., and P. Kilby. 1975. *Agriculture and Structural Transformation: Economic Strategies in Late-Developing Countries.* Oxford, U.K.: Oxford University Press.

Jones, A., H. Breuning-Madsen, M. Brossard, A. Dampha, J. Deckers, O. Dewitte, T. Gallali, S. Hallett, R. Jones, M. Kilasara, P. Le Roux, E. Micheli, L. Montanarella, O. Spaargaren, L. Thiombiano, E. Van Ranst, M. Yemefack, and R. Zougmore. 2013. *Soil Atlas of Africa*. European Commission, Luxembourg: Publications Office of the European Union.

Karamba, R. W. 2013. "Input Subsidies and Their Effect on Cropland Allocation, Agricultural Productivity, and Child Nutrition: Evidence from Malawi." PhD dissertation, American University, Washington, DC.

Karamba, R. W., and P. C. Winters. 2015. "Gender and Agricultural Productivity: Implications of the Farm Input Subsidy Program in Malawi." *Agricultural Economics* 46 (3): 357–74.

Kasanga, J., O. Daka, J. Chanda, and A. Undi. 2010. "Model and Implementation Plan for the Expanded Food Security Pack Programme." Lusaka, Zambia: IMCS Limited.

Kherallah, M., C. Delgado, E. Gabre-Madhin, N. Minot, M. Johnson. 2002. *Reforming Agricultural Markets in Africa: Achievements and Challenges.* Washington, DC: IFPRI.

Kilic, T., E. Whitney, and P. Winters. 2015. "Decentralised Beneficiary Targeting in Large-Scale Development Programmes: Insights from the Malawi Farm Input Subsidy Programme." *Journal of African Economies* 24 (1): 26–56.

KMOA (Kenya Ministry of Agriculture). 2007. *The National Accelerated Agricultural Inputs Access Program (NAAIAP): Program Design and Implementation Framework.* Nairobi, Kenya: KMOA.

———. 2013. "Unpublished Data Files for Nakuru Fertilizer Prices." Nairobi, Kenya: Ministry of Agriculture, Market Information Bureau for Maize Prices.

Levine, N. K. 2015. "Do Input Subsidies Crowd In or Crowd Out Other Soil Fertility Management Practices? Evidence from Zambia." Master's thesis paper, Michigan State University, Lansing, MI.

Levy, S. (ed.). 2005. *Starter Packs: A Strategy to Fight Hunger in Developing and Transition Countries? Lessons from the Malawi Experience, 1998–2003*. Wallingford, U.K.: Centre for Agriculture and Bioscience International.

Lipton, M. 2006. "Can Small Farmers Survive, Prosper, or Be the Key Channel to Cut Mass Poverty?" *Electronic Journal of Agricultural and Development Economics* 3 (1): 58–85.

Liverpool-Tasie, L. S. O. 2014a. "Do Vouchers Improve Government Fertilizer Distribution? Evidence from Nigeria." *Agricultural Economics* 45 (4): 393–407.

———. 2014b. "Farmer Groups and Input Access: When Membership Is Not Enough." *Food Policy* 46 (June): 37–49.

———. 2014c. "Fertilizer Subsidies and Private Market Participation: The Case of Kano State, Nigeria." *Agricultural Economics* 45 (6): 663–78.

Liverpool-Tasie, L., and S. Salau. 2013. "Spillover Effects of Targeted Subsidies: An Assessment of Fertilizer and Improved Seed Use in Nigeria." Discussion Paper 01260, Development Strategy and Governance Division, IFPRI, Washington, DC.

Liverpool-Tasie, L., and H. Takeshima. 2013. "Input Promotion Within a Complex Subsector: Fertilizer in Nigeria." *Agricultural Economics* 44 (6): 581–94.

———. 2015. "Fertilizer Subsidies, Political Influence and Local Food Prices in Sub-Saharan Africa: Evidence from Nigeria." *Food Policy* 54: 11–24.

Logistics Unit. 2015. *Final Report on the Implementation of the Agricultural Inputs Subsidy Programme, 2014–15*. Lilongwe, Malawi: Logistics Unit.

Lunduka, R., J. Ricker-Gilbert, and M. Fisher. 2013. "What Are the Farm-Level Impacts of Malawi's Farm Input Subsidy Program? A Critical Review." *Agricultural Economics* 44 (6): 563–79.

Marenya, P., and C. Barrett. 2009. "State-Conditional Fertilizer Yield Response on Western Kenyan Farms." *American Journal of Agricultural Economics* 91 (4): 991–1006.

Mason, N., and T. S. Jayne. 2013. "Fertilizer Subsidies and Smallholder Commercial Fertilizer Purchases: Crowding Out, Leakage, and Policy Implications for Zambia." *Journal of Agricultural Economics* 64 (3): 558–82.

———. 2015. "Fertilizer Subsidies and Smallholder Commercial Fertilizer Purchases: Crowding Out, Leakage and Policy Implications for Zambia." *Journal of Agricultural Economics* 64 (3): 558–82.

Mason, N. M., T. S. Jayne, and R. Mofya-Mukuka. 2013. "Zambia's Input Subsidy Programs." *Agricultural Economics* 44 (6): 613–28.

Mason, N. M., T. S. Jayne, and R. J. Myers. 2015. "Smallholder Supply Response to Marketing Board Activities in a Dual Channel Marketing System: The Case of Zambia." *Journal of Agricultural Economics* 66 (1): 36–65.

Mason, N. M., T. S. Jayne, and N. van de Walle. 2013. "Fertilizer Subsidies and Voting Patterns: Political Economy Dimensions of Input Subsidy Programs." Selected paper presented at the Agricultural and Applied Economics Association's (AAEA) and Canadian Agricultural Economics Society Joint Annual Meeting, Washington, DC, August 4–6.

Mason, N., and J. Ricker-Gilbert. 2013. "Disrupting Demand for Commercial Seed: Input Subsidies in Malawi and Zambia." *World Development* 45 (May): 75–91.

Mason, N. M., and M. Smale. 2013. "Impacts of Subsidized Hybrid Seed on Indicators of Economic Well-Being Among Smallholder Maize Growers in Zambia." *Agricultural Economics* 44 (6): 659–70.

Mason, N., and S. Tembo. 2015. "Do Input Subsidy Programs Raise Incomes and Reduce Poverty among Smallholder Farm Households? Evidence from Zambia." Working Paper 92, Indaba Agricultural Policy Research Institute, Lusaka, Zambia.

Mason, N. M., A. Wineman, L. Kirimi, and D. Mather. 2015. "The Effects of Kenya's 'Smarter' Input Subsidy Program on Smallholder Behavior and Incomes: Do Different Quasi-Experimental Approaches Lead to the Same Conclusions?" Working Paper, Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya.

Mather, D., and T. S. Jayne. 2015. "Fertilizer Subsidies and the Role of Targeting in Crowding Out: An Assessment of Smallholder Fertilizer Demand in Kenya." Selected paper prepared for the International Conference of Agricultural Economics, Milan, Italy, August 9–14.

Mather, D., B. Waized, D. Ndyetabula, A. Temu, I. Minde, and D. Nyange. 2015. "The Role of Relative Prices, Agro-Ecological Factors, and Household Soil and Crop Management Practices in Explaining Smallholder Profitability of Fertilizer Use on Maize in Tanzania." MSU working paper, Michigan State University, East Lansing, MI.

Matsumoto, T., T. Yamano, and D. Sserunkuuma. 2012. "Technology Adoption in Agriculture: Evidence from Experimental Intervention in Maize." In *An African Green Revolution: Finding Ways to Boost Productivity on Small Farms*. The Netherlands: Springer.

Maur, J. C., and B. Shepherd. 2015. *Connecting Food Staples and Input Markets in West Africa: A Regional Trade Agency for ECOWAS Countries*. Washington, DC: World Bank.

Mellor, J. 1976. *New Economics of Growth*. New York: Cornell University Press.

Minten, B., B. Koru, and D. Stifel. 2013. "The Last Mile(s) in Modern Input Distribution: Pricing, Profitability, and Adoption." *Agricultural Economics* 44 (6): 629–46.

Minten, B., D. Stifel, and S. Tamru. 2014. "Structural Transformation of Cereal Markets in Ethiopia Structural Transformation of Cereal Markets." *Journal of Development Studies* 50 (5): 611–29. http://doi.org/10.1080/00220388.2014.887686.

Mkwara, B., and D. Marsh. 2011. "Effects of Maize Fertilizer Subsidies on Food Security in Malawi." Working Paper in Economics 14/11, Department of Economics, University of Waikato, Hamilton, New Zealand.

Morris, M., V. Kelly, R. Kopicki, and D. Byerlee. 2007. *Fertilizer Use in African Agriculture: Lessons Learned and Good Practice Guidelines*. Washington, DC: World Bank.

Msolla, M. M. 2014. "Effects of the Subsidy Voucher Program on Fertilizer Markets: Example from Tanzania." Paper presented at the International Fertilizer Development Center Training on Fertilizer Value Chain-Supply System Management and Servicing Farmers' Needs, Accra, Ghana, April 14–18.

Muraoka, R. 2015. "Three Essays on Land and an Intensive Farming System in Sub-Saharan Africa: Evidence from Kenya." Unpublished PhD dissertation, Michigan State University, East Lansing, MI. ISBN: 9781321736038.

Namonje-Kapembwa, T., T. S. Jayne, and R. Black. 2015. "Does Late Delivery of Subsidized Fertilizer Affect Smallholder Maize Productivity and Production?" Selected paper presented at the Agricultural and Applied Economics Association and Western Agricultural Economics Association Annual Meeting, San Francisco, CA, July 26–28.

NCPB (National Cereals and Produce Board). 2013. "NCPB Fertilizer Business Portfolio." PowerPoint presentation by NCPB official, NCPB, Nairobi, Kenya.

Nelson, F., and L. Olson. 1978. "Specification and Estimation of a Simultaneous-Equation Model with Limited Dependent Variables." *International Economic Review* 19 (3): 695–709.

Ochola, R. O., and F. Nie. 2015. "Evaluating the Effects of Fertilizer Subsidy Programmes on Vulnerable Farmers in Kenya." *Journal of Agricultural Extension and Rural Development* 7 (6): 192–201.

PAM (Programme Against Malnutrition). 2005. *The Targeted Food Security Pack for Vulnerable but Viable Farmers: Programme Implementation Guidelines for the 2005/2006 Agricultural Season*. Lusaka, Zambia: PAM.

Pan, L., and L. Christiaensen. 2012. "Who Is Vouching for the Input Voucher? Decentralized Targeting and Elite Capture in Tanzania." *World Development* 40 (8): 1619–33.

Powlson, D., P. Gregory, W. Whalley, J. Quinton, D. Hopkins, A. Whitmore, P. Hirsch, and K. Goulding. 2011. "Soil Management in Regional to Sustainable Agriculture and Ecosystem Services." *Food Policy* 36: 72–87.

Ragassa, Catherine, Antony Chapoto, and Shashi Kolavalli. 2014. *Maize Productivity in Ghana*. GSSP Policy Note 5. Washington, DC: IFPRI. http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/128263.

Rashid, A. 2010. "Agro-Economic Feasibility of Fertilizer Use for Wheat Cultivation in Rainfed Regions of Pakistan." *Journal of Agricultural Research* 48 (3): 353–59.

Rashid, S., P. Dorosh, M. Malek, and S. Lemma. 2013. "Modern Input Promotion in Sub-Saharan Africa: Insights from Asian Green Revolution." *Agricultural Economics* 44: 705–21.

Resnick, D., and D. Mather. 2015. "Agricultural Inputs Policy under Macroeconomic Uncertainty: Applying the Kaleidoscope Model to Ghana's Fertilizer Subsidy Program (2008–2015). Draft working paper. IFPRI/Michigan State University, Washington, DC, and East Lansing, MI.

Ricker-Gilbert, J. 2014. "Wage and Employment Effects of Malawi's Fertilizer Subsidy Program." *Agricultural Economics* 45 (3): 337–53.

Ricker-Gilbert, J., and T. S. Jayne. 2011. "What Are the Enduring Effects of Fertilizer Subsidy Programs on Recipient Farm Households: Evidence from Malawi." Staff Paper 2011–09, Department of Agricultural, Food, and Resource Economics, Michigan State University, East Lansing, MI.

———. 2012. "Do Fertilizer Subsidies Boost Staple Crop Production and Reduce Poverty Across the Distribution of Smallholders in Africa? Quantile Regression Results from Malawi." Selected Paper for the Triennial Meeting of the International Association of Agricultural Economists, Foz Do Iguacu, Brazil, August 18–24.

———. 2015. "What Are the Dynamic Effects of Fertilizer Subsidies on Commercial Fertilizer Demand and Maize Production? Panel Evidence from Malawi." Paper prepared for presentation at the symposium on "Using Smart Subsidies to Support Small Scale Farmers in Africa," International Conference of Agricultural Economists, Milan, Italy, August 18.

Ricker-Gilbert, J., T. S. Jayne, and E. Chirwa. 2011. "Subsidies and Crowding Out: A Double-Hurdle Model of Fertilizer Demand in Malawi." *American Journal of Agricultural Economics* 93 (1): 26–42.

Ricker-Gilbert, J. N. Mason, F. Darko, and S. Tembo. 2013. "What Are the Effects of Input Subsidy Programs on Maize Prices? Evidence from Malawi and Zambia." *Agricultural Economics* 44 (6): 671–86.

Roy, R., R. Misra, J. Lesschen, and E. Smaling. 2003. "Assessment of Soil Nutrient Balance: Approaches and Methodologies." *Fertilizer and Plant Nutrition Bulletin* 14.

Sauer, J., and H. Tchale. 2009. "The Economics of Soil Fertility Management in Malawi." *Review of Agricultural Economics* 31(3): 535–60.

Sheahan, M., R. Black, and T. S. Jayne. 2013. "Are Kenyan Farmers Under-Utilizing Fertilizer? Implications for Input Intensification Strategies and Research." *Food Policy* 41: 39–52.

Sheahan, M., J. Olwande, L. Kirimi, and T. S. Jayne. 2014. "Targeting of Subsidized Fertilizer under Kenya's National Accelerated Agricultural Input Access Program (NAAIAP)." Working Paper 52, Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya.

Shimeles, A., D. Z. Gurara, and D. B. Tessema. 2015. "Market Distortions and Political Rent: The Case of Fertilizer Price Divergence in Africa." Institute for the Study of Labor. Discussion Paper 8998, Institute for the Study of Labor, Bonn, Germany.

Sianjase, A., and V. Seshamani. 2013. "Impacts of Farmer Inputs Support Program on Beneficiaries in Gwembe District in Zambia." *Journal of Environmental Issues and Agriculture in Developing Countries* 50 (1): 40–50.

Smale, M., E. Birol, and D. Asare-Marfo. 2014. "Smallholder Demand for Maize Hybrids in Zambia: How Far Do Seed Subsidies Reach?" *Journal of Agricultural Economics* 65 (2): 349–67.

Snapp, S., T. S. Jayne, W. Mhango, T. Benson, and J. Ricker-Gilbert. 2014. "Maize-Nitrogen Response in Malawi's Smallholder Production Systems." Paper presented at National Symposium on Eight Years of FISP—Impact and What Next? Lilongwe, Malawi, July 14–15.

Snapp, S., and B. Pound, eds. 2011. *Agricultural Systems: Agroecology and Rural Innovation for Development*. Cambridge, MA: Academic Press.

Takeshima, H., and L. Liverpool-Tasie. 2015. "Fertilizer Subsidies, Political Influence, and Local Food Prices in Sub-Saharan Africa: Evidence from Nigeria." *Food Policy* 54: 11–24.

Takeshima, H., and E. Nkonya. 2014. "Government Fertilizer Subsidy and Commercial Sector Fertilizer Demand: Evidence from the Federal Market Stabilization Program in Nigeria." *Food Policy* 47 (August): 1–12.

Takeshima, H., E. Nkonya, and S. Deb. 2012. "Impact of Fertilizer Subsidies on the Commercial Fertilizer Sector in Nigeria: Evidence from Previous Fertilizer Subsidy Schemes." Working Paper 23, IFPRI Nigeria Strategy Support Program II, Abuja, Nigeria.

Tittonell, P., and K. Giller. 2013. "When Yield Gaps Are Poverty Traps: The Paradigm of Ecological Intensification in African Smallholder Agriculture." *Field Crops Research* 143: 76–90.

Tittonell, P., B. Vanlauwe, N. de Ridder, and K. Giller. 2007. "Nutrient Use Efficiencies and Crop Responses to N, P, and Manure Applications in Zimbabwean Soils: Exploring Management Strategies Across Soil Fertility Gradients." *Field Crop Research* 100: 348–68.

Tscharntke, T., Y. Clough, T. Wanger, L. Jackson, I. Motzke, I. Perfecto, J. Vandermeer, and A. Whitbread. 2012. "Global Food Security, Biodiversity Conservation and the Future of Agricultural Intensification." *Biological Conservation* 151(1): 53–59.

van de Walle, N. 2001. *African Economies and the Politics of Permanent Crisis, 1979–1999*. Cambridge, U.K.: Cambridge University Press.

Vanlauwe, B., J. Kihara, P. Chivenge, P. Pypers, R. Coe, and J. Six. 2011. "Agronomic Use Efficiency of N Fertilizer in Maize-Based Systems in Sub-Saharan Africa Within the Context of Integrated Soil Fertility Management." *Plant and Soil* 339 (1–2): 35–50.

Vondolia, G. K., H. Eggert, and J. Stage. 2012. "Nudging Boserup? The Impact of Fertilizer Subsidies on Investment in Soil and Water Conservation." Discussion Paper 12-08, Environment for Development and Resources for the Future, Washington, DC.

Wanzala-Mlobela, M., P. Fuentes, and S. Mkumbwa. 2013. "NEPAD Policy Study: Practices and Policy Options for the Improved Design and Implementation of Fertilizer Subsidy Programs in Sub-Saharan Africa." Midrand, South Africa: NEPAD Planning and Coordinating Agency.

Ward, M., and P. Santos. 2010. "Looking beyond the Plot: The Nutritional Impact of Fertilizer Policy." Selected paper prepared for presentation at the Agricultural and Applied Economics Association (AAEA), Canadian Agricultural Economics Society, and Western Agricultural Economics Association Joint Annual Meeting, Denver, Colorado, July 25–27.

Westberg, N. B. 2015. "Exchanging Fertilizer for Votes?" Working Paper 12/2015, Norwegian University of Life Sciences School of Economics and Business, Ås, Norway.

Wiredu, A., M. Zeller, and A. Diagne. 2015. "What Determines Adoption of Fertilizers among Rice-Producing Households in Northern Ghana?" *Quarterly Journal of International Agriculture* 54 (3): 263.

World Bank. 2007. *World Bank Assistance to Agriculture in Sub-Saharan Africa: An IEG Review.* Independent Evaluation Group. Washington, DC: World Bank.

———. 2008. *World Development Report 2008: Agriculture for Development*. Washington, DC: World Bank.

———. 2014. *Tanzania Public Expenditure Review: National Agricultural Input Voucher Scheme (NAIVS).* Washington, DC: World Bank.

Xu, Z., W. J. Burke, T. S. Jayne, and J. Govereh. 2009. "Do Input Subsidy Programs 'Crowd In' or 'Crowd Out' Commercial Market Development? Modeling Fertilizer Demand in a Two-Channel Marketing System." *Agricultural Economics* 40 (1): 79–94.

Yanggen, D., V. Kelly, T. Reardon, and A. Naseem. 1998. "Incentives for Fertilizer Use in Sub-Saharan Africa: A Review of Empirical Evidence on Fertilizer Response and Profitability." International Development Working Paper 70, Michigan State University, East Lansing, MI.

Yawson, D. O., F. Armah, E. K. Afrifa, and S. K. N. Dadzie. 2010. "Ghana's Fertilizer Subsidy Policy: Early Field Lessons from Farmers in Central Region." *Journal of Sustainable Development: Africa* 12 (3): 191–203.

Yusuf, Vincent. 2015. "Agro Dealers Stop Farm Inputs Supply over N38bn Debt." *Daily Trust,* July 30. http://www.dailytrust.com.ng/daily/index.php/agriculture/61217-agro-dealers-stop-farm-inputs-supply-over-n38bn-debt.

ZMACO (Zambia Ministry of Agriculture and Cooperatives), Agricultural Consultative Forum, and FSRP (Food Security Research Project). 2002. "Developments in Fertilizer Marketing in Zambia: Commercial Trading, Government Programs, and the Smallholder Farmer." Food Security Research Project Working Paper 4, FSRP, ZMAC, Lusaka, Zambia. http://aec.msu.edu/fs2/zambia/wp4zambia.

ZMAL (Zambia Ministry of Agriculture and Livestock). 2012. *Farmer Input Support Programme Implementation Manual, 2012/2013 Agricultural Season.* Lusaka, Zambia: ZMAL.

———. 2014. *Farmer Input Support Programme Implementation Manual.* Lusaka, Zambia: ZMAL.

ZMFNP (Zambia Ministry of Finance and National Planning). Various years. Estimates of Revenue and Expenditure: Activity Based Budget. Lusaka, Zambia.

Zulu, P., T. Kalinda, and G. Tembo. 2014. "Effects of the Maize Input Subsidy Program on Groundnuts Production in Zambia." *Journal of Agricultural Science* 6 (7): 253–64.