



Review

Review: Taking stock of Africa's second-generation agricultural input subsidy programs



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ARTICLE INFO

Keywords:

Sub-Saharan Africa
Fertilizer
Subsidies
Agricultural productivity
Crop response to fertilizer
Crowding out

ABSTRACT

Input subsidy programs (ISPs) remain one of the most contentiously debated development issues in sub-Saharan Africa (SSA). After ISPs were phased out during the 1980s and 1990s, the landscape has changed profoundly since the early 2000s. By 2010, at least 10 African governments initiated a new wave of subsidy programs that were designed to overcome past performance challenges. This study provides the most comprehensive review of recent evidence to date regarding the performance of these second generation ISPs, synthesizing nearly 80 ISP-related studies from seven countries (Ghana, Nigeria, Kenya, Tanzania, Malawi, Zambia, and Ethiopia). We specifically evaluate ISP impacts on total fertilizer use, food production, commercial input distribution systems, food prices, wages, and poverty. We also consider measures that could enable ISPs to more cost-effectively achieve their objectives. We find that ISPs can quickly raise national food production, and that receiving subsidized inputs raises beneficiary households' grain yields and production levels at least in the short-term. However, the overall production and welfare effects of subsidy programs tend to be smaller than expected. Two characteristics of program implementation consistently mitigate the intended effects of ISPs: (1) subsidy programs partially crowd out commercial fertilizer demand due to difficulties associated with targeting and sale of inputs by program implementers, and (2) lower than expected crop yield response to fertilizer on smallholder-managed fields. If these challenges could be addressed, ISPs could more effectively mitigate the concurrent challenges of rapid population growth and climate change in SSA.

1. Introduction

Input subsidy programs (ISPs) are among the most contentiously debated of development issues in sub-Saharan Africa (SSA).¹ These government programs, through which farmers receive fertilizer (and in some cases seed) at below-market prices, were largely phased out during the 1990s because the emerging consensus was that they only weakly contributed to agricultural productivity growth, food security, and poverty reduction goals, imposed unsustainable burdens on national treasuries, and hindered the development of private input distribution systems (Kherallah et al., 2002; Morris et al., 2007; World Bank, 2008).

However, starting in the early 2000s, the landscape changed quickly and profoundly. Shortly after African governments committed to raise

expenditures on agriculture under the 2003 Maputo Declaration, several countries (re-) introduced ISPs. Skepticism based on the past performance of ISPs was countered with arguments that a new genre of “smart” subsidies could be designed to correct for past shortcomings with careful targeting and the involvement of the private sector in the programs (Morris et al., 2007).² These arguments carried the day and by 2010 at least 10 African countries accounting for more than half of the region's population had adopted “second-generation” ISPs designed to raise agricultural productivity in a “market smart” way (Jayne & Rashid, 2013). In recent years, total expenditures on ISPs by these 10 countries have ranged from approximately 600 million to 1 billion US dollars per year and accounted for roughly 14–26% of their combined annual public expenditures on agriculture (Table 1).³ Large-scale ISPs remain the centerpiece of many African governments' agricultural

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¹ Hereafter Africa for simplicity.

² The main criteria for smart ISPs are described in Section 3.

³ Due to the omission of state-level subsidies in Nigeria from these figures (see Table 1 note), they likely under-estimate, potentially by a large degree, total public expenditures on ISPs in SSA. Anecdotal evidence suggests that Nigerian federal and state subsidies alone may total 800 million US dollars per year.

Table 1
ISP and broader agricultural sector spending, 2011–2014.

Country	Year	ISP cost (million US\$)		Thousands of MT of ISP fertilizer distributed (C)	Public expenditure on agriculture (million US\$) (D)	ISP cost as% share of public agricultural spending [= (B/D) * 100] (E)
		Official source (A)	Computed using secondary data (B) ^a			
<i>Universal subsidy</i>						
Mali	2011	na	44	173	213	20.5
	2012	na	17	65	195	8.6
	2013	na	20	75	204	9.9
	2014	na	18	84	199	9.0
Burkina Faso	2011	na	25	25	291	8.5
	2012	na	35	36	310	11.2
	2013	na	47	51	351	13.4
Ghana ^c	2011	53	63	176	148	42.4
	2012	64	75	174	141	53.2
	2013	33	47	167	149	31.6
	2014	0	0	0	109	0.0
Senegal	2011	na	47	54	182	25.8
	2012	na	37	41	374	9.9
	2013	na	30	36	368	8.2
	2014	na	36	43	390	9.2
Nigeria ^d	2011	na	81	264	817	9.9
	2012	na	92	249	788	11.6
	2013	na	96	264	802	12.0
	2014	na	86	256	795	10.8
<i>Targeted subsidy programs</i>						
Kenya	2011	15	40	57	356	11.2
	2012	na	64	68	386	16.7
	2013	na	70	81	444	15.7
	2014	na	77	112	479	16.1
Malawi	2011	127	106	149	345	30.8
	2012	151	77	177	355	21.6
	2013	207	95	213	350	27.1
	2014	168	157	208	352	44.5
Tanzania	2011	94	40	110	349	11.5
	2012	76	53	126	326	16.4
	2013	na	46	105	338	13.6
	2014	na	43	112	332	12.8
Zambia	2011	184	120	182	613	19.6
	2012	166	134	184	325	41.3
	2013	113	84	188	376	22.3
	2014	na	81	208	407	19.9
<i>Ethiopia's program (not considered a "subsidy" program by the Ethiopian government)^b</i>						
	2011	na	289 (62)	551	530	54.5 (11.6)
	2012	na	449 (60)	633	771	58.2 (7.8)
	2013	na	289 (43)	449	850	34.0 (5.0)
	2014	na	307 (48)	597	937	32.8 (5.1)
<i>Total across 10 countries</i>						
	2011	na	854 (627)	1741	3844	22.2 (16.3)
	2012	na	1033 (644)	1753	3971	26.0 (16.2)
	2013	na	825 (578)	1629	4232	19.5 (13.7)
	2014	na	853 (594)	1671	4358	19.6 (13.6)

Source: Official source ISP costs (column A) and MT of program fertilizer distributed (column C) data are from the ministries of agriculture and/or finance in the respective countries. Public expenditure on agriculture data (column D) are from the "Statistics on Public Expenditures for Economic Development" (SPEED) database (International Food Policy Research Institute, 2017) and the Regional Strategic Analysis and Knowledge Support System (ReSAKKS). Fertilizer prices used in the calculations for column B (see notes) are from the Africa Fertilizer Information Portal (http://africafertilizer.org/prices_national.html) for all countries except Ethiopia. Ethiopia prices are from the Ethiopia Agricultural Transformation Authority (EATA).

^a Computed costs to government are (column C × open market fertilizer price × subsidy rate) plus, following Jayne and Rashid (2013), a 12% markup to account for administrative and other programmatic costs. The annual median of monthly open market urea prices is used as a proxy for fertilizer price.

^b Ethiopia market prices from EATA are substantially lower than market prices elsewhere in the region and appear not to be indicative of the CIF price. We therefore also do the Ethiopia calculations using open market urea prices in Kenya as a proxy. Ethiopia figures in parentheses use the Ethiopia open market price and the figures not in parentheses use the Kenya price.

^c Beginning in 2013 Ghana's program was aimed at targeting households with 2 acres dedicated to producing staples, but evidence suggests this policy had little impact on actual targeting (Houssou and Andam Asante-Addo, 2017).

^d Nigeria figures reflect federal-level subsidies only; states often add additional subsidies but insufficient data are available to account for state-level subsidies in this table. The Nigeria figures are therefore a lower bound. na = Information not available. The authors thank Shahidur Rashid and Asfaw Lemma for their support in preparing parts of this table. Comprehensive data for more recent years are not yet available.

development programs.

How did this change occur so quickly, how effective have these second generation ISPs been, and how might the programs be further improved? Motivated by these questions and a growing receptivity among many African governments to reform their ISPs,⁴ this article has two main objectives. First, we synthesize the growing empirical evidence on African ISPs to determine the extent to which ISPs are evolving toward smart subsidy principles and affecting total fertilizer use, crop production, private sector input distribution systems, food prices, wages, and poverty rates. Our second objective is to consider ways in which ISPs could be redesigned to better achieve national policy objectives, and identify complementary or alternative policies that could increase the effectiveness of ISPs.

While there have been some recent reviews of ISPs (Druilhe and Barreiro-Hurlé, 2012; Wanzala-Mlobela et al., 2013; Jayne and Rashid, 2013), empirical studies on the topic have proliferated since their publication. This article synthesizes nearly 80 ISP-related studies and focuses on the evidence from seven countries with large input subsidy programs (Ghana, Nigeria, Kenya, Tanzania, Malawi, Zambia, and Ethiopia). We include dozens of new studies that were not part of earlier reviews, and cover a period of time during which ISPs were argued to become “smarter” in their design and implementation. Moreover, many of the more recent studies take advantage of newly available farm panel survey data, which enable better identification of the effects of ISPs on farmer behavior and welfare. The time is ripe for an updated comprehensive review.^{5,6}

2. Rationale for ISPs

Subsidies have long been recognized by economists as potentially useful tools when the benefits to society of a given behavior exceed its private benefits (Gautam, 2015). For example, market constraints may override a farmer’s incentive to use fertilizer even though the societal benefits of increased production could make the added expenditure worthwhile. Subsidies can also be justified under specific circumstances, e.g. “when there are potential economies of scale, strong learning-by-doing effects, potential for innovations with large transformative impacts, strategic trade intervention opportunities, or environmental benefits, as well as for social equity considerations” (Gautam, 2015, p. 87).

In making the case for ISPs, Dorward et al. (2008) present a conceptual framework that describes African rural economies as being in a low-productivity poverty trap, out of which risk-averse farm households are unable to extricate themselves. Input use and productivity remain low in equilibrium, reinforcing staple crop self-sufficiency goals and stifling crop and income diversification. The result is a vicious cycle of: (i) unstable food prices, (ii) disincentivized investment in surplus staple production, (iii) decreasing consumer willingness to rely on markets for staple foods, and (iv) limited opportunities to escape from low productivity subsistence staple cultivation. Proponents argue that by relaxing these constraints, ISPs “can not only help the affected farmers but also potentially unleash strong dynamic general equilibrium impacts – boosting agricultural productivity, nutrition, and incomes; lowering food prices; raising real wages, employment and broader economic growth through forward and backward linkages; promoting structural transformation; and strongly contributing to

poverty reduction” (Gautam, 2015, p. 88).

Other motivations for ISPs have focused on learning effects. Fertilizer use may be low in some areas because farmers have too little 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 et al., 2014). Farmers might then continue to purchase it commercially after the subsidy ends. The possibility of such a learning effect would be most pronounced in areas where fertilizer use is uncommon but likely to be profitable at commercial market prices.

3. Drivers of the resurgence of African ISPs

Despite the arguments for ISPs outlined above, by the 1990s there was widespread agreement that their costs generally exceeded their benefits (Kherallah et al., 2002). While most ISPs in Africa had been phased out by 1995, many have since been revived, starting around 2005. We identify five main reasons for the resurgence of ISPs in Africa.

First, many African governments never accepted the tenets of structural adjustment and cut ISPs only under duress and pressure from international lenders (Jayne & Rashid, 2013). African leaders had many incentives to revive ISPs: they are politically popular and are often considered an appropriate response to former colonial policies that discriminated against smallholder farmers. Political economy analyses (e.g., van de Walle, 2001; Jayne et al., 2002) contend that influential rural elites benefitted from ISPs and lobbied forcefully for their re-emergence.

Second, starting around 2000, many African governments experienced a relaxation of the constraints on public budgets resulting from the Highly Indebted Poor Countries (HIPC) debt forgiveness programs and a shift by international donors from highly conditional aid to direct budget support (Jayne and Rashid, 2013). With the autonomy afforded by the relaxation of public budget constraints, governments had more resources available to re-institute ISPs.

Thirdly, multi-party political systems had emerged in much of Africa by the early 2000s, spurring competition to attract and reward constituents with public coffers (Levy, 2005). ISPs, featuring free or highly discounted inputs to millions of farmers, were one of the promises that leaders often made (e.g., in Malawi, Nigeria, and Zambia) to garner the rural vote.

While each of these three factors was important, the watershed event that heralded the re-emergence of African ISPs was the so-called “Malawi miracle”. After reaching office in 2005, Malawi’s politically embattled President Bingu wa Mutharika immediately gained local support after announcing a large-scale ISP in defiance of World Bank recommendations. Preliminary assessments (Dugger, 2007; Alliance for a Green Revolution in Africa (AGRA), 2009) suggested that Malawi’s ISP had transformed the country from a perennial maize importer into a maize exporter and substantially reduced rural poverty. An AGRA report (2009, p. 2) referred to Malawi as “a model of success showing the rest of the African governments the way towards a sustainable version of the African green revolution”. The Malawi ISP also received public relations boosts from prominent advocates including Jeffrey Sachs and Pedro Sanchez of the Millennium Villages Project, Akin Adesina of AGRA, and the major fertilizer production and distribution company, YARA. The initial critical acclaim of the Malawi ISP led to President Mutharika receiving several international prizes.

More recent and detailed analyses have cast significant doubts on the Malawi program’s early successes (Lunduka et al., 2013; Ricker-Gilbert et al., 2011; Chinsinga and Poulton, 2014; Jayne and Rashid, 2013; Messina et al., 2017).⁷ Nevertheless, as argued by Jayne and

⁴ For example, since 2014, several governments have either reformed (Malawi and Ghana (Houssou and Andam Asante-Addo (2017))), temporarily discontinued (Ghana (Kato and Greeley, 2016) and Tanzania (Mather and Ndyetabula, 2016)), or set up plans to redesign (Zambia and Kenya) their ISPs.

⁵ See [Supplementary Online Appendix A](#) for a summary of the key features of these countries’ ISPs.

⁶ The Government of Ethiopia does not consider its subsidizing of the operations of farmers’ organizations to be an ISP but it makes fertilizer available to farmers at prices roughly 25% below commercial prices in other countries in the region.

⁷ See [Messina et al. \(2017\)](#) for a summary, new empirical evidence, and a discussion of the role of a data error in generating the ‘Malawi miracle’ narrative. The authors conclude that “the Malawian production miracle appears, in part, to be a myth” (p. 1).

Rashid (2013), “the Malawi case had an important ‘primacy effect’ on the continent, convincing numerous governments to undertake similar ISPs”.⁸ Indeed, by 2010, at least nine other African countries had established second-generation ISPs (Jayne & Rashid, 2013).

Many of these programs were pitched as “smart subsidy programs”, a term that allowed politicians and supporters to argue that despite the disappointing track record of African ISPs, it was possible to learn from experience and overcome prior implementation problems. Key elements of smart subsidy programs as articulated by Morris et al. (2007) and the World Bank (2008) include that the programs: (i) support the development of private sector fertilizer markets; (ii) focus on areas and farmers with currently low but potentially profitable fertilizer use; (iii) be part of a “wider sector strategy that recognizes the importance of supplying complementary inputs, strengthening output markets, and appropriately sequencing interventions” (Morris et al., 2007); and (iv) have an exit strategy. While these criteria are clearly a useful guide, few questions were raised regarding how they could be implemented in practice and whether well known past implementation problems could be realistically overcome.

The final major factor contributing to the re-emergence of African ISPs was the global food price crisis in 2007 and 2008 (Jayne and Rashid, 2013). During this time, panic over the availability and high prices of food supplies on world markets convinced many analysts and African leaders to support ISPs to promote national food self-sufficiency. In response to these concerns, the World Bank shifted its position on ISPs, and started to support and even finance programs in Ethiopia, Tanzania, Zambia, and Malawi. Bank representatives have acknowledged the need to address criticism that the Bank was insensitive to the food security needs of poor countries, and, informally, Bank staff felt that the organization would retain greater influence over the design and implementation of ISPs if it contributed to their financing (Rohrbach, 2014).⁹

4. Potential pitfalls of ISPs

4.1. Questionable profitability of fertilizer use at market prices

An assumption of most ISPs is that after obtaining fertilizer at subsidized prices for a given period, farmers will be more likely to continue using fertilizer even at commercial market prices (Dorward et al., 2008). Fertilizer-responsive modern varieties, irrigation, and fertilizer were the main ingredients of Asia’s Green Revolution (Gulati and Narayanan, 2003), and there are many areas of Africa where fertilizer is highly valued by farmers. Recent evidence, however, calls this assumption into question.

For one, there is likely selection bias in the literature on farmer returns to fertilizer use in Africa. Studies of fertilizer tend to be concentrated where its use is common. Almost by definition, these locations are where fertilizer use provides high returns. Moreover, prior to the mid-2000s, most estimates of crop yield response to fertilizer for African smallholder farmers came from experiment stations or on-farm trials. Experiments and trials, however, tend to be managed by scientists in terms of seed type, planting date, row spacing, seed spacing, weeding, and even choice of farmers to participate. When second generation ISPs were being instituted in the mid-2000s, very few nationally representative smallholder farm data sets were available to understand staple crop response to fertilizer on fields managed by smallholder farmers and accounting for the various resource constraints that they face.

Cases of crop damage from drought, flooding, pests, or disease are

⁸ For example, in 2009, Ethiopian President Zenawi hosted President Mutharika in Ethiopia to learn about the ‘Malawi miracle’.

⁹ For a discussion of the policy processes surrounding the establishment of and changes to ISPs in SSA, see Resnick et al. (2017) and the references therein.

often dropped from studies of fertilizer trials, even though these are real possibilities for farmers purchasing inputs in the real world.¹⁰ Trial plots tend to be carefully chosen for suitability and are generally smaller than farmer-managed plots, providing greater sunlight ‘edge effects’ that likely raise crop response to fertilizer.¹¹ In short, while on-farm trials may provide accurate estimates of the crop response rates to fertilizer that farmers *may get* under favorable conditions, they are often not representative of the response rates that smallholder farmers *do get* (Snapp et al., 2014). For these reasons it is possible (even likely) that prior estimates of crop response rates (or agronomic efficiency, hereafter AE) from researcher-managed farm trials overstate fertilizer profitability on fields managed by smallholder farmers.

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 for obtaining estimates of the AE that farmers actually obtain. They take into account farmers’ actual behavior and resource constraints (we call these farmer-managed plots as opposed to researcher-managed plots) and many are nationally representative. Further, survey data retain cases of crop damage, floods, weeds, inadequate labor, etc., which represent valid cases that should be included in estimations of on-farm averages for AE. Moreover, under certain assumptions, panel data can be used to control for the effects of all time-constant (even unobserved) factors correlated with fertilizer use that might otherwise bias researchers’ estimates of AE.

To demonstrate how different farmer-managed and researcher-managed results can be, consider that *researcher-managed* farm trials in east/southern Africa have typically produced yield response estimates ranging from 18 to 40 kg maize per kg nitrogen (kg/kg) (Whitbread et al., 2013; Vanlauwe et al., 2011). Given prevailing fertilizer and farm-gate maize prices in the region, these rates usually show highly profitable returns to farmers applying nitrogen. By contrast, Table 2 shows our inventory of recent survey-based estimates of AE from farmer-managed fields. The response rates range from 5 to 26 kg maize/kg nitrogen applied, and most of the estimates are below 15 kg/kg. These mean response rates also mask substantial variability in response rates across farms and even plots on a given farm (Marenja & Barrett 2009; Xu et al., 2009; Burke et al., 2016; Burke et al., 2017).

A value cost ratio (VCR) is typically used to quantify farm input profitability. This is the ratio of the value of additional output (in this case, the average response rate times the per kg price of maize) to the cost of a unit of input (the per kg price of fertilizer).¹² A VCR of one technically indicates a break-even investment, but to account for the indirect costs of fertilizer use (risk premiums, added weeding costs, transportation costs, etc.), a VCR of two is typically used as the benchmark for reliably profitable adoption (e.g., Xu et al., 2009; Sauer and Tchale, 2009), dating back to work by the Food and Agriculture Organization (1975) and Anderson et al. (1977). The VCR estimates in the far right column of Table 2 show very few cases over two, with most falling between one and two. Thus most survey-based studies suggest marginal or moderate levels of fertilizer profitability and only when risk and other unmeasured costs are not taken into account. Given this questionable profitability of fertilizer use at market prices, the assumption of many ISPs that farmers will continue using fertilizer at market prices after subsidies end is a very strong one.

¹⁰ In such cases, the objective of trials is to assess the potential gains in yield or net returns to using fertilizer under favorable conditions and management practices, not to estimate the yield gains that farmers are actually obtaining given their highly constrained conditions.

¹¹ See Bevis and Barrett (2017) for a discussion of edge effects in the context of the inverse size-productivity relationship.

¹² Average and marginal VCRs may differ at high levels of fertilizer use because of diminishing returns. However, most studies that compute both average and marginal VCRs are similar because of the relatively low levels at which fertilizer is used in sub-Saharan Africa (e.g., Xu et al., 2009a,b; Sheahan et al., 2013).

Table 2
Recent estimates of fertilizer application and maize response rates in SSA.
Source: Jayne and Rashid (2013) and sources listed in the table.

Source	Geographic focus	% maize fields receiving commercial fertilizer use	Application rate among users	Estimated average (AP) or marginal (MP) crop response to nitrogen (kg crop/kg N)	Estimated average (AVCR) or marginal value-cost ratio (MVCR)
Sheahan et al. (2013)	20 districts of Kenya where maize is commonly grown, 5 years of data from 1997 to 2010.	Ranges from 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 ranging from 1.3 (high-potential maize zone) to 3.7 (eastern lowlands)
Marenja 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 and Yamano (2011)	100 locations in Western and Central Kenya	74%	94.7 kg fertilizer product/ha maize	MP = 14.1 to 19.8 kg hybrid maize/kg N	MVCR ranging from 1.05 to 1.24 for hybrid maize
Morris et al. (2007)	W/E/S Africa			E/S Africa: AP = 14 kg maize/kg N (median) W. Africa: AP = 10 kg maize/kg N (median)	AVCR: E/S Africa: 2.8 W. Africa: 2.8
Minten et al. (2013)	Northwestern Ethiopia	69.1% of maize plots fertilized	65.3 kg N/ha	MP = 12 kg maize/kg N on-time planting; 11 kg maize/kg N for late planting	MVCR 1.4 to 1.0 (varying by degree of remoteness)
Pan and Christiaensen (2012)	Kilimanjaro District, Tanzania			MP = 11.7 kg maize/kg N	
Xu et al. (2009)	AEZ Ila in Zambia (relatively good quality soils/rainfall suitable for maize production)	56.4% on maize	61.4 kg N/ha (among users)	AP = 18.1 (range from 8.5 to 25.5) MP = 16.2 (range from 6.9 to 23.4)	AVCR: Accessible areas = 1.88 Remote areas = 1.65
Burke et al. (2017)	Zambia (nationally representative), 2001, 2004, 2008	36–38% of maize fields; 45–50% of maize area	35.2 N/ha maize	AP = 9.6 kg maize/kg N	AVCR = 0.3 to 1.2 for 98% of sample, depending on soil pH level
Ragasa and Chapoto (2017)	Ghana (nationally representative), 2012	45% of farmers	48.6 N/ha maize	MP ranging between 18 and 25 depending on ecology and seed type	MVCR ranging between 2.6 and 3.7 at commercial prices
Ricker-Gilbert and Jayne (2012)	Malawi, national panel data	59% of maize fields	47.1 N/ha maize	MP = 8.1 kg maize/kg N	MVCR ranging between 0.6 to 1.6 at commercial prices
Chibwana et al. (2012)	Malawi – farmer-managed field data in Kasungu and Machinga Districts		MP = 9.6 to 12.0 kg maize/kg N	MVCR 1.4 to 1.8	
Chirwa and Dorward (2013)	Malawi – national LSMS survey data			MP = Negative to 9.0 kg maize/kg N	MVCR: Below 2.0
Snapp et al. (2014)	Malawi – nationally representative LSMS survey data	27% (maize plots)	62.9 kg/ha maize	MP = 5.3 kg maize/kg N for monocrop; 8.8 for intercropped maize	MVCR ranging from 1.04 to 1.38
Liverpool-Tasie et al. (2017a)	Nigeria – national LSMS survey data			AP = 7.6–7.7 kg maize/kg N MP = 7.7–7.8 kg maize/kg N	AVCR ranging from 1.25 to 1.71 % of maize plots with AVCR ≥ 1 = 51–56%
Mather et al. (2016)	Tanzania – national LSMS survey data	15.9% (2009) 20.6% (2011) 17.9% (2013)	55.6 N/ha maize	AP = 8.2 to 11.8 kg maize/kg N MP = 7.0 to 7.8 kg maize/kg N Varies by zone	% of maize plots with MVCR ≥ 1 = 49–53% AVCR 1.17 to 2.26 MVCR 1.00 to 1.49 Varies by zone

Note: Table adapted from Jayne and Rashid (2013) to include all subsequently published studies known to the authors on cereal response rates in SSA.

4.2. Factors affecting crop response to fertilizer and implications for ISPs

The literature shows generally lower maize response to fertilizer on smallholder-managed plots than may be expected for several reasons. First, water availability is a fundamentally different issue in SSA as compared to the rest of the world, and particularly Asia. The vast majority (96%) of SSA's cultivated land is rainfed, and water stress and single-harvest agriculture are common (FAO, 2016). Crop yields and yield response to fertilizer tend to be lower and less predictable when farmers rely on rainfed water supply (Jayne and Rashid 2013). It is unsurprising, then, to find fertilizer use has been higher on irrigated land in other parts of the world (Ekasingh et al., 2004; Rashid et al., 2013). Water control may be an increasingly important determinant of fertilizer use rates in the future with more variable climate conditions. That said, projected increases in irrigation in SSA over the next several decades are negligible: even optimistically, less than 10% of SSA's land will be irrigated by 2060 (You et al., 2012).

Poor soil quality is another major obstacle to improving crop response to fertilizer on many African smallholders' fields. The efficiency of fertilizer use depends on the *availability* of pre-existing nutrients stocked in the soil and those applied as fertilizer (Jones et al., 2013).¹³ Nutrient availability is partially determined by soil characteristics, not just the presence of nutrients. Common measures of soil characteristics include pH (soil chemistry), soil organic matter (SOM)¹⁴ (soil biology), and texture (soil physics). Low pH, low SOM, and large particle (sandy) soils are common in Africa, and all associated with lower AE (Burke et al., 2017, 2016; Jones et al., 2013; Marenja and Barrett, 2009).

For example, evidence from Zambia suggests average response rates of 2.1 kg maize/kg basal fertilizer on highly acidic soils (pH 4.3 and below, 51% of maize plots in the sample), 3.7 kg/kg on moderately acidic soils (pH of 4.4–5.4, 47% of maize plots), and 7.8 kg/kg on less acidic soils (pH of 5.5 and up, 2% of maize plots) (Burke et al., 2017). This is driven by the well-established facts that root growth can be stunted and essential nutrients can be strongly bound in the soil solution in acidic soils, rendering them unavailable to plants (Jones et al., 2013). However, with adequate pH management (e.g., liming), fertilizer use can be profitable on soils that would otherwise be acidic. A key example is the Brazilian Cerrado (World Bank, 2009; Rada, 2013; Jayne and Rashid, 2013).

Beyond the current soil quality constraints, increases in rural population density throughout Africa are adding to land pressures. This leads to reduced fallowed area in any given year and fewer fallow periods over time for a given plot of land. Without proper management, this will likely lead to further soil degradation and lower yield response to fertilizers, despite rising use of hybrid seed (Stoorvogel and Smaling; 1990; Tittonell and Giller, 2013). Messina et al. (2017) conclude that “Malawi has reached a tipping point, where soil organic matter is below a minimum threshold for support of crop productivity”. Moreover, Giller et al. (2006) and Tittonell et al. (2007) argue the yield gains currently possible through plant genetic improvements are largely out of reach to small farmers whose soils are depleted and crop response to fertilizer is low.

Multi-crop farming systems that, for example, integrate legumes could increase SOM, add nitrogen, and raise fertilizer's AE (Giller and Candisch, 1995; Snapp et al., 2010). Farm management practices, including minimum-tillage, manure and compost application, and using cover crops, can also add organic matter to soils (Lal, 2011). African farmers, however, do not often adopt these practices because they are constrained in ways that policy makers and researchers do not always

¹³ 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. (2016).

¹⁴ 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.

understand. Research around identifying these constraints (which may include risk aversion and other factors beyond the budget, education, and marketing constraints normally considered), could be a critical component of developing holistic strategies for improving ISPs.

It is important to consider yield response-limiting factors when developing or describing the expected benefits of ISPs. Past discussions that have focused on limited access to input and credit markets have outlined important issues, but also mask the importance and rising urgency of deteriorating soil fertility, poor soil and water management, declining fallows, and increasing population pressure. The view that low fertilization rates in Africa are solely driven by budget limitations and gaps in input and credit market access that can be overcome using fertilizer subsidies is only partially correct. More importantly, this view ignores important agronomic constraints that also currently limit fertilizer demand, and which could be relaxed by more appropriate policies. We discuss potential options in Section 6.2.

4.3. The feasibility and evidence of smart targeting

A key goal of second-generation subsidy programs in Africa was appropriate targeting of beneficiaries. Eligibility criteria for ISP participation vary markedly across (and sometimes within) countries. Some programs officially target “resource-poor” households (e.g., Kenya's National Accelerated Agricultural Inputs Access Program, NAAIAP) or those that cannot afford fertilizer at unsubsidized prices (e.g., Malawi's Farm Input Subsidy Program, MFISP, previously known as the Agricultural Input Subsidy Program, AISP). Other programs officially prioritize female-headed households (e.g., Malawi's MFISP and Zambia's Food Security Pack Program). Still others have a minimum or maximum landholding- or area cultivated-related eligibility criterion (e.g., Zambia's Farmer Input Support Program (ZFISP) and Kenya's NAAIAP). Given this heterogeneity, one approach would be to evaluate each ISP against its stated targeting criteria. In most of these cases there is little correlation between the official targeting criteria and the characteristics of farmers and households actually receiving input subsidies (Ricker-Gilbert et al., 2011; Pan and Christiaensen, 2012; Mason et al., 2013; Sheahan et al., 2014; Kilic et al., 2015). Pan and Christiaensen (2012) report that Tanzania's 2009 program did not allocate fertilizer to targeted beneficiaries any more effectively than random allocation would have. In a similar vein, Houssou and Zeller (2011) find that despite using a community-based targeting approach that was ostensibly intended to improve targeting of the poor, Malawi's AISP failed to reach 46% of poor households while allocating inputs to 54% of non-poor households. These findings highlight the difficulties of adhering to official targeting guidelines given the institutional, political, and cultural contexts in which ISPs are implemented (Chinsinga, 2012).¹⁵

Another approach to assess targeting performance of ISPs is with respect to the common goal of raising input use. As shown by Xu et al. (2009a, b), Ricker-Gilbert et al. (2011), Mason and Jayne (2013), Jayne et al. (2013), and Mather and Jayne (2015), on average and keeping other factors constant, ISPs tend to have the greatest impact on total fertilizer use when administered in areas where the private sector has been inactive and when they target less wealthy households that cannot afford fertilizer at commercial prices, whether wealth be measured in landholding, assets, or *ex ante* poverty status. Evidence also indicates that targeting of female-headed households is particularly effective in raising total fertilizer use (Mason & Jayne, 2013).

4.3.1. Targeting by gender

Despite the aforementioned criterion, the weight of the empirical evidence in the ISPs literature suggests that female-headed and male-

¹⁵ Also see Houssou and Zeller (2011) for an extensive discussion of the challenges and costs associated with different targeting mechanisms.

headed households are equally likely to participate in ISPs and receive the same quantity of inputs on average, other factors constant.¹⁶ This is the case for all reviewed studies on Ghana's Fertilizer Subsidy Program (GFSP) (Vondolia et al., 2012), Kenya's NAAIAP (Sheahan et al., 2014), Zambia's ZFISP (Mason and Jayne, 2013; Mason et al., 2013; Mason & Smale, 2013), and Nigeria's ISPs prior to the Growth Enhancement Support Scheme (GES) (Liverpool-Tasie, 2014a; Takeshima and Nkonya, 2014). It is also true for the bulk of studies on Malawi's MFISP (Chibwana et al., 2014; Chirwa et al., 2010; Fisher and Kandiwa, 2014; Karamba and Winters, 2015; Kilic et al., 2015; Mason and Ricker-Gilbert, 2013; Ricker-Gilbert and Jayne, 2011; Sibande et al., 2017). Where there are differences, the findings suggest that women are less likely to receive (or receive a smaller quantity of) inputs for MFISP (Chibwana et al., 2012; Dionne and Horowitz, 2016; Ricker-Gilbert et al., 2011), for Tanzania's ISP (Pan and Christiaensen, 2012), and for Nigeria's GES (Wossen et al., 2017). Thus, ISPs in SSA generally fail to meet the criterion of favoring female-headed households.

4.3.2. Targeting by landholding size

The empirical record generally suggests that households with more land are more likely to receive ISP inputs or receive a larger quantity of such inputs on average, *ceteris paribus*. Of the nearly 80 studies reviewed, only one suggests that households with more land are less likely to receive ISP inputs (Sheahan et al., 2014), and only a handful suggest that an increase in landholding size has no effect on ISP receipt (Mason and Smale, 2013; Pan and Christiaensen, 2012; Takeshima and Nkonya, 2014). While participation in ISPs is generally higher among households with more land, the extent to which this is the case varies considerably across countries. (See Supplementary Online Appendix B for details.)

That said, participation rates alone mask larger disparities in the share of subsidized inputs received by households of different landholding size. Even in countries where the input pack size is supposedly standardized (e.g., 200 kg fertilizer per household in Zambia since 2009/10, 100 kg/household in Malawi throughout the duration of MFISP), the quantities received often vary markedly across beneficiary households, and households with more land are more likely to receive larger quantities of inputs (Ricker-Gilbert et al., 2011; Mason and Ricker-Gilbert, 2013; Mason and Jayne, 2013; Sibande et al., 2017). In Zambia, for example, 52.6 percent of farm households with 10 to 20 hectares of operated farmland were recipients of Zambia's ISP in 2010/11, and they received 346 kg of fertilizer per household; by contrast, only 21.7 percent of households with two hectares and below were recipients, and they obtained only 43 kg per household (Jayne et al., 2011).

4.3.3. Targeting by wealth or ex ante poverty status

The effects of assets, wealth, and *ex ante* poverty status on ISP receipt are mixed, especially in the case of Malawi (Chibwana et al., 2012, 2014; Chirwa et al., 2010; Fisher and Kandiwa, 2014; Karamba and Winters, 2015; Kilic et al., 2015; Mason and Ricker-Gilbert, 2013; Ricker-Gilbert and Jayne, 2012; Ricker-Gilbert et al., 2011; Sibande et al., 2017). Differences in methodology and the definitions of assets, wealth, or poverty measures likely underlie many of the varying results from Malawi. However, based on their detailed study of MFISP participants, Kilic et al. (2015, p. 29) argue that the program "is not poverty targeted" and that "relatively well off [households] in terms of wealth and landholdings, rather than the poor or the wealthiest" are more likely to participate and receive more subsidized inputs.

In a cross-sectional study of GFSP receipts, it was found that asset wealth in Ghana's Volta region was 44% greater amongst beneficiaries

compared to those not receiving fertilizer subsidies (Vondolia et al., 2012). Kenya's NAAIAP favored households in the bottom four wealth quintiles (Sheahan et al., 2014), while no farm asset effects are found for the country's universal National Cereals and Produce Board (NCPB) fertilizer subsidy program (Mather & Jayne, 2015). In Zambia, targeting is decidedly *not* pro-poor, as smallholder households in the lowest income per adult equivalent quintile received just 5% of all ZFISP fertilizer in 2010/11, while those in the highest quintile received 42% of it (Mason & Tembo, 2015).

4.3.4. Targeting and political factors

There is considerable evidence of politically motivated targeting of ISP inputs, but the groups targeted (incumbent supporter, opposition supporter, or swing voter) vary across countries and, in the case of Malawi, different studies reach different conclusions. Empirical evidence in Ghana and Kenya suggests ISP benefits were focused on areas that supported the opposition in the last presidential election (Banful, 2011; Mather and Jayne, 2015). In Zambia, in contrast, results based on multiple nationally-representative surveys consistently suggest areas won by the ruling party in the last presidential election received significantly more subsidized fertilizer than those in areas the party lost; moreover, the quantity of subsidized fertilizer received was increasing in the ruling party's margin of victory (Mason et al., 2017a, 2017b).

The findings from Malawi related to which groups of voters/partisans are targeted are too mixed to draw general conclusions, where disparate findings likely stem from differences in data, methods, and years under consideration (Mason and Ricker-Gilbert, 2013; Brazys et al., 2015; Westberg, 2015; Dionne and Horowitz, 2016). However, for Malawi and Nigeria, there is some evidence that communities with resident elected leaders or communities close to leaders' hometowns receive significantly more subsidized fertilizer on average (Ricker-Gilbert and Jayne, 2011; Fisher and Kandiwa, 2014; Sibande et al., 2017; Takeshima and Liverpool-Tasie, 2015). Overall, there is mounting empirical evidence of the politicization of ISP allocations in SSA, but the nature of the politicization varies across countries and within countries over time (Chinsinga and Poulton, 2014; Westberg, 2015).

4.3.5. Targeting and elite capture

Empirical evidence from several countries suggests that social capital factors also lead to elite capture of ISP benefits. In Tanzania, Pan and Christiaensen (2012) found 60% of households receiving input vouchers included a village official. They also found households with elected officials and voucher committee members were up to four times more likely to receive input vouchers than others. Similarly, evidence from Zambia and Malawi suggests that households with links to traditional authorities are more likely to receive input subsidies (Kilic et al., 2015; Mason and Smale, 2013). In Nigeria, relatives of farm group leaders got more subsidized fertilizer under voucher programs where a single voucher was given to the farmer group, but not under programs where farmers were each given their own vouchers (Liverpool-Tasie, 2014a, 2014b). Thus, in all SSA countries where this issue has been investigated empirically, there is evidence that social capital factors influence access to subsidized inputs.

5. Impacts of African ISPs

Having described the rationale, challenges, and evidence on targeting of ISPs, the most important remaining question is how effective have they been since their resurgence in the early 2000s. We investigate this question through an array of criteria based on the (sometimes implicit) smart goals of ISPs for affecting households and the broader economy.

¹⁶ See Supplementary Online Appendix B for the key findings of and brief descriptions of the data and methods used in nearly 80 studies from across the seven countries that we focus on in this review. Additional insights from studies in other SSA countries are also included where relevant.

5.1. Household-level effects of ISPs

5.1.1. Fertilizer and improved seed use

One of the first sets of ISP impacts to be empirically estimated was on household demand for fertilizer at commercial prices. Originally investigated by Xu et al. (2009a, b), empirical assessments examine the extent to which subsidized fertilizer “crowds in” or “crowds out” commercial fertilizer demand using multivariate regression analysis. When there is crowding out (in), a 1-kg increase in subsidized fertilizer or seed acquired by a household leads to a less (more) than 1-kg increase in total fertilizer or seed demand. Understanding the crowding out/in effects of ISPs is critical for understanding the programs’ impacts on total household input use and incremental crop production (Ricker-Gilbert et al., 2011; Jayne et al., 2013).

Of all the relevant studies for SSA, only two cases show evidence of crowding in: under a voucher pilot program in Kano State, Nigeria (Liverpool-Tasie, 2014a) and in areas with low private sector commercial retailing activity in Zambia (Xu et al., 2009a, b). All other results suggest crowding out of commercial fertilizer demand by subsidized fertilizer in Kenya, Malawi, Nigeria (under the Federal Market Stabilization Program), and Zambia, and similarly for improved maize seed in Malawi and Zambia (Jayne et al., 2013; Mason and Jayne, 2013; Mason and Ricker-Gilbert, 2013; Mather and Jayne, 2015; Ricker-Gilbert et al., 2011; Takeshima & Nkonya, 2014; Takeshima et al., 2012).

The magnitude of the effects of ISPs on demand for unsubsidized inputs varies considerably across countries. Estimates suggest that an additional 100 kg of ISP fertilizer crowds out up to 50 kg of commercial fertilizer in Kenya, 35 kg in Nigeria, 18 kg in Malawi, and 13 kg in Zambia (Takeshima et al., 2012; Jayne et al., 2013; Mather and Jayne, 2015). The negative effects on demand for commercial fertilizer are logically largest in Kenya, where private sector fertilizer markets were well developed and most farmers already used fertilizer before the re-introduction of subsidies (Mather and Jayne, 2015; Sheahan et al., 2014). In general, the extent to which ISP inputs decrease 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 activity, and in areas with lower agro-ecological potential. The latter point raises a question regarding the long-run potential of ISPs in low-potential areas: what is the likelihood of sustaining a commercial market where fertilizer use may only be achieved at subsidized prices?

5.1.2. Crop yields

The econometric evidence on ISP effects on yield increases (a central goal of all ISPs) is surprisingly thin. In Kenya, Malawi, Nigeria, and Zambia, limited evidence suggests positive ISP effects on maize yields (Chibwana et al., 2014; Holden and Lunduka, 2010; Karamba and Winters, 2015; Mason et al., 2013; Mason et al., 2017a, 2017b; Wossen et al., 2017). However, crowding out by and late delivery of ISP inputs are likely attenuating these effects (Burke et al., 2016; Namonje-Kapembwa et al., 2015; Xu et al., 2009), as are poor soil quality and the minimal use of complementary practices to raise crop yield response to fertilizer (Marenya and Barrett, 2009; Burke, 2012; Jayne and Rashid, 2013).

Related to this point, it is worth noting that the price ratio between grains and fertilizer has been fairly constant over time for most countries in the region (Liverpool-Tasie et al., 2017b). For example, Fig. 1 shows maize to fertilizer price ratios for locations throughout Zambia and Kenya. None of these price ratios have a statistically significant positive or negative trend over time.¹⁷ If the ratio of grain to fertilizer prices continues to be flat, only changes in response rates can drive

meaningful changes in fertilizer profitability.

5.1.3. Crop area planted

The empirical record is mixed as to whether ISPs induce an expansion of crop area planted or changes in the shares of land planted to different crops. In land-scarce Kenya, NAAIAP appears to have no effect on farmers’ total area planted (Mason et al., 2017). In relatively land-abundant Zambia, the program seems to have induced expansion of total and maize area planted without adversely affecting the area of land devoted to other crops (Goeb, 2011; Mason et al., 2013; Zulu et al., 2014). The results from Malawi are again difficult to generalize. Chibwana et al. (2012) suggests smallholders have increased the share of land devoted to maize, but Holden and Lunduka (2010) and Karamba (2013) (using different datasets) suggest that Malawi’s ISP has encouraged maize intensification and reduced the maize share of total area planted. We thus conclude that ISPs have had heterogeneous effects on the area planted to maize and other crops.

5.1.4. Crop production, crop income, and crop marketing

Where *ceteris paribus* estimates are available (Kenya, Malawi, and Zambia), the sum of evidence suggests ISPs have had modest, positive effects on household-level maize production. Kenya’s NAAIAP was found to raise recipient households’ maize production by 361 kg on average (Mason et al., 2017). The increases in Malawi (165 kg of maize per 100 kg of ISP fertilizer) and Zambia (188 kg of maize per 100 kg of ISP fertilizer) are considerably smaller (Mason et al., 2013; Ricker-Gilbert and Jayne, 2012). The latter two estimates are for fertilizer only whereas the Kenya/NAAIAP estimate is for 100 kg fertilizer and 10 kg improved maize seed. Differences in the design and implementation of the three ISPs might also contribute to the differences in their impacts. Of the three programs, only Kenya’s program successfully targeted resource-poor farmers and distributed inputs through vouchers redeemable at agro-dealers.

The empirical evidence on the effects of ISPs on crop income is more variable. Estimates suggest Kenya’s NAAIAP had negligible income effects overall but increased net crop income among the poor. Malawian and Zambian ISPs have small positive effects of net crop income overall (Mason et al., 2016; Mason and Tembo, 2015; Ricker-Gilbert and Jayne, 2012). Finally, quantile regression results suggest Malawi’s ISP has larger effects on higher percentiles of the maize production distribution. For example, a 100-kg increase in ISP fertilizer raises the 10th percentile of the maize production distribution by only 75 kg whereas it raises the 90th percentile by 261 kg, *ceteris paribus* (Ricker-Gilbert and Jayne, 2012). The authors do not speculate why this might be the case but argue that the results suggest it will be difficult for ISPs such as Malawi’s to simultaneously reduce poverty and substantially raise staple crop production (*ibid.*).

To our knowledge, only one study (Sibande et al., 2017) has explored the effects of ISPs on maize market participation. While there is insufficient evidence to draw broad conclusions, Sibande et al.’s results suggest that receipt of subsidized fertilizer through Malawi’s FISP increases a household’s probability of selling maize, their quantity of maize sold, and households’ share of total maize production sold (which the authors refer to as ‘maize commercialization’).

5.1.5. Food security, poverty, and assets

We find only two studies that directly assess the effects of ISPs on food security, and the results are mixed (Gilligan et al., 2009; Karamba, 2013). Several studies, however, estimate ISP impacts on household income, poverty, and/or asset wealth. Results for Kenya and Zambia suggest these ISPs reduce poverty severity by several percentage points, but do not reduce poverty incidence (Mason et al., 2017; Mason and Smale, 2013; Mason and Tembo, 2015). 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. The results for Malawi, again, are mixed: Chirwa (2010) suggests that receiving ISP

¹⁷ Results not shown to conserve space but are available from the authors upon request.

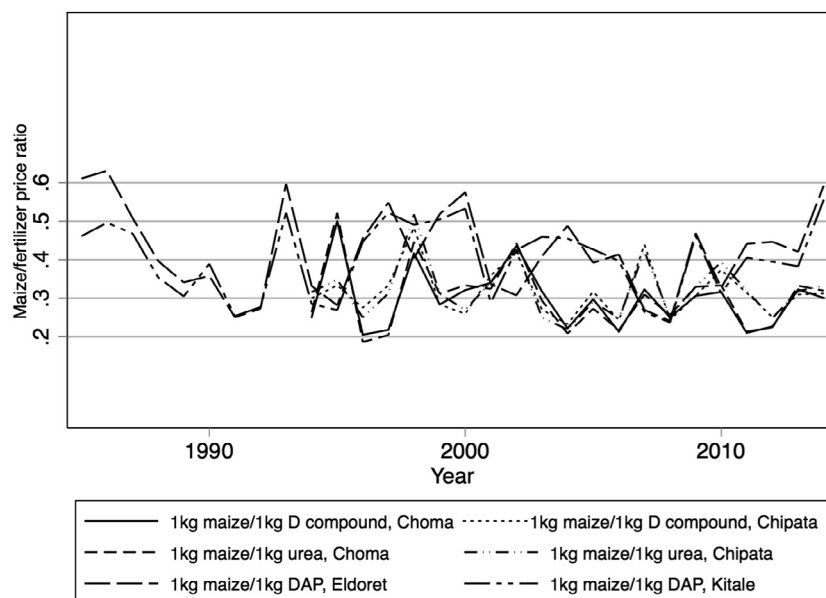


Fig. 1. Various maize/fertilizer price ratios for Zambia and Kenya over time.

Sources: Zambia Central Statistical Office, Kenya Ministry of Agriculture, Kenya Market Information Bureau.

inputs raises per capita incomes by 8.2%, but [Ricker-Gilbert and Jayne \(2012\)](#) find no significant MFISP effects on household assets, total income, or off-farm income.

5.1.6. Other soil fertility and natural resource management practices

In addition to the oft-stated objectives, ISPs could have spillover effects on other outcomes, such as households' use of other soil fertility management (SFM) or natural resource management (NRM) practices. Experimental evidence from Mali suggests that access to free fertilizer induces households to increase fertilizer use but also to re-optimize their use of other inputs, such as herbicide or labor ([Beaman et al., 2013](#)). Otherwise, the empirical evidence suggests ISPs have no impact on SFM/NRM practices at best, or negative effects at worst.

For example, soil and water conservation practices are unaffected by participation in Ghana's program ([Vondolia et al., 2012](#)). [Kassie et al. \(2015\)](#) and [Koppmair et al. \(2017\)](#) obtain similar findings for the effects of Malawi's FISP on a suite of NRM practices, particularly after controlling for time invariant unobserved heterogeneity in the latter study. Similarly, [Holden and Lunduka \(2010, 2012\)](#) and [Levine \(2015\)](#) find that ISP fertilizer does not affect Malawian and Zambian smallholders' use of organic manure, and [Holden and Lunduka \(2010\)](#) find no effect of Malawi's ISP on crop rotation. However, evidence from Zambia suggests that the country's ISP reduces fallowing and intercropping of maize with other crops, while incentivizing continuous maize cultivation on the same plot over time ([Levine, 2015](#); [Mason et al., 2013](#)). This is troubling because reduced fallowing and increased maize monocropping and continuous cultivation will likely reduce soil fertility and undermine maize yield stability and the potential for yield gains in the future. Indeed, this is the conclusion reached by [Gerber \(2016\)](#), whose simulation model results suggest that while Zambia's ISP raises maize yields in the short run, its long-term impacts will be limited "because it fails to adequately build up soil organic matter (SOM) levels"—something that complementary SFM practices could help to address.

5.1.7. Dynamic or enduring effects

A common argument made for ISPs is that by stimulating learning about the inputs, they may help farm households break out of poverty traps and kick-start growth processes ([Chirwa and Dorward, 2013](#)). In addition, some distributed inputs (e.g., phosphorus) may affect crop productivity for several years after initial application. Whether there is

empirical evidence of dynamic or enduring effects of ISPs depends on the outcome variable and the context.

In Malawi, where fertilizer use is relatively widespread, the weight of the evidence suggests no enduring ISP effects on maize production, assets, and income, but possibly eventual crowding in effects on commercial fertilizer demand after an initial period of crowding out ([Ricker-Gilbert and Jayne, 2011, 2017](#)). In Mozambique, where commercial fertilizer use is relatively low and potential for learning effects may be greater, [Carter et al.'s \(2014\)](#) RCT results for a pilot ISP suggest substantial, positive enduring effects on many but not all of the outcome variables considered. However, some of these dynamic effects might be due to concurrent efforts by the International Fertilizer Development Center to strengthen agro-dealer networks and fertilizer supply in the same areas in Mozambique. Overall, the literature suggests that ISPs have the potential to raise incomes and reduce poverty severity while the programs operate but there is not yet sufficient evidence to claim whether the programs are likely to have enduring effects after discontinuation.

5.2. Market-level and general equilibrium effects of ISPs

The aggregate effects of ISPs on the just discussed outcomes and the economy-wide effects on food prices and labor markets may differ from those on individual households. A handful of studies provide some illumination on these impacts.

5.2.1. Aggregate fertilizer use

Based on the micro-econometric evidence discussed above, most ISPs crowd out demand for commercial fertilizer. However, a substantial share (roughly one third in Malawi and Zambia) of fertilizer intended for ISPs is diverted before reaching intended beneficiaries and resold as commercial fertilizer at or near commercial prices ([Jayne et al., 2013](#); [Jayne et al., 2015](#); [Mason and Jayne, 2013](#)). When such diversion is taken into account in national level estimates of ISP impacts on total fertilizer use, the degree of crowding out is even greater than at the household level (*ibid.*) Based on diversion estimates of 33%, one MT of ISP fertilizer supplied raises total fertilizer use by just 0.38 MT in Kenya, 0.55 MT in Malawi, and 0.58 MT in Zambia ([Jayne et al., 2015](#)). Although ISPs raise total fertilizer use, as shown by [Mason and Jayne \(2013\)](#) and [Jayne et al. \(2013, 2015\)](#), the social benefit-cost ratios of these programs are depressed by problems of diversion and crowding

out of commercial fertilizer markets. Moreover, diversion almost certainly implies that program implementers are among the greatest beneficiaries of ISPs (see Jayne et al., 2015).

5.2.2. Crop production and food price levels

The only studies that directly estimate aggregate ISP effects on national production have been conducted for Malawi and take either a partial equilibrium or computable general equilibrium (CGE) modeling approach (Arndt et al., 2016; Dorward and Chirwa, 2013). These studies suggest increases in national maize production as a result of Malawi's ISP (e.g., in 2006/07) of 9–23% (with larger increases among targeted households).

Though typically not stated as an explicit objective, if ISPs do aim to raise national production one can reasonably assume there would be lower food prices, which could benefit urban consumers and rural net food buyers. The effects of ISPs on food prices have been estimated for Malawi, Zambia, and Nigeria. Ricker-Gilbert et al. (2013) and Arndt et al. (2016) suggest modest reductions in retail maize prices as a result of Malawi's and Zambia's ISPs on the order of 1–4%. Arndt et al. (2016) also suggest MFISP reduced overall food prices by 2–3%. Though not directly comparable, Dorward and Chirwa's (2013) findings indicate a decrease in the maize-to-wage price ratio as a result of MFISP due to both reductions in maize prices and increases in wages. Takeshima and Liverpool-Tasie (2015) found that input subsidy programs in Nigeria had no statistically significant effect on local maize and rice prices. Thus, in general, the empirical evidence suggests that ISPs in SSA have had little or no effect on local grain prices. This somewhat perplexing result might be explained by the fact that many countries remained at import parity pricing throughout the implementation of ISPs (i.e., the ISPs did not raise food production by enough to turn the country from a grain importer to an exporter or self-sufficiency).

5.2.3. Agricultural labor markets, income, and poverty

ISPs could benefit poor non-beneficiary households if the programs increase demand for their agricultural labor and increase agricultural wages. Results from Malawi suggest its ISP does raise agricultural wages, but the magnitudes of the effects vary across studies. CGE model results suggest increases in average farm wages of 5–8% (Arndt et al., 2016), whereas micro-econometric estimates suggest increases of 1% (Ricker-Gilbert, 2014). Malawi's ISP also appears to result in small increases (decreases) in labor demand (supply) (Ricker-Gilbert, 2014). To our knowledge, the only study examining the agricultural labor market impacts of an input subsidy-related program in SSA outside of Malawi is Gilligan et al. (2009), who find no evidence that Ethiopia's Food Security Program affected beneficiaries' labor market participation.

There is similarly very little empirical evidence on ISP effects on national income or poverty statistics. CGE modeling work from Malawi (Arndt et al., 2016) suggests that the 2006/07 MFISP reduced the national poverty headcount ratio by 1.6–2.7 percentage points and that reductions in poverty in rural and urban areas were similar, if not slightly greater in urban areas. Micro-econometric evidence from Nigeria suggests that the GES reduced the poverty headcount ratio among program participants by 17.7 percentage points. The evidence base is still too thin to draw broad conclusions about the effectiveness of ISPs as poverty reduction strategies. Relatedly, a major knowledge gap is understanding the cost effectiveness of ISPs in SSA relative to other types of poverty reduction programs and investments (e.g., cash transfers, investments in rural roads, agricultural research and development, etc.). We return to this point in the conclusions section.

5.2.4. Voting and election results

Once established, ISPs often become entrenched agricultural policies. The conventional wisdom is that scaling back of ISPs is politically damaging, whereas establishing or scaling up ISPs is politically beneficial. The empirical record on these relationships, however, is not so clear. Evidence from Malawi suggests that MFISP substantially

increased support for President Mutharika and his Democratic Progressive Party in the 2009 election (Brazys et al., 2015; Dionne and Horowitz 2016). But Mason et al. (2017) find no evidence that the Zambia ISP affected the number or share of votes won by the incumbent in the 2006 and 2011 presidential elections.

6. Conclusion

ISPs are among the most hotly debated public policy issues in SSA. Fortunately, many studies have been carried out in recent years, and the weight of the evidence has coalesced around some particular findings that can provide the foundation for an emerging consensus. This article reviews nearly 80 empirical studies on the wave of second generation input subsidy programs implemented in Africa since 2000. We also identify components of a holistic agricultural productivity growth strategy that could improve the contribution of ISPs to national development objectives.

6.1. Synthesis of main findings

ISPs have proven to be effective in raising national food production quickly – in one growing season. Most studies show that receiving subsidized inputs raises beneficiary households' grain yields and production levels in the year they receive the subsidy, but the overall production and welfare effects of subsidy programs tend to be smaller than originally expected. Attenuated impacts are consistently driven by two characteristics of implemented programs that were either unanticipated or underappreciated: (1) the tendency of subsidy programs to partially crowd out commercial fertilizer demand and the diversion of subsidy benefits along distribution channels, hence contributing less than expected to national food production; and (2) lower than expected crop yield response to fertilizer on most smallholder-managed fields.

The magnitude of crowding out depends on the characteristics of beneficiary farmers and is smallest when beneficiaries have not purchased commercial fertilizer in the past. Under such conditions, crowding in of commercial fertilizer purchases may even occur. Panel survey data, however, consistently show subsidy programs often distribute fertilizer to beneficiaries who did regularly purchase fertilizer in the past, which in turn reduces their reliance on commercial markets. The tendency for subsidy programs to target farmers who have regularly purchased fertilizer in the past may partially be because it is less costly to reach these farmers, but evidence from several countries also indicates that relatively well-off farmers, measured by farm size, asset wealth, and social connections (who would be more likely to buy commercial fertilizer) disproportionately benefit from ISPs. Targeting of fertilizer subsidies to non-poor households would therefore fail to enable poor households to directly generate more income or food from subsidy programs and in a static sense would represent a regressive redistribution of income from public programs. General equilibrium impacts on wages and commodity prices could conceivably be important but the limited evidence to date suggests that they tend to be small.

Production impacts of ISPs are also likely lower than expected because a large proportion of smallholder farmers use fertilizer under adverse prevailing agro-ecological conditions in terms of the physical, chemical, and biological makeup of their soils. Survey-based evidence consistently shows smallholder farmers obtain highly variable response rates to fertilizer across farms and plots. On average, farmers' response rates are also substantially lower than those obtained from researcher-managed trials.

Likely because of these hindering factors, there is limited evidence that fertilizer subsidy programs kick-start dynamic growth processes. Carter et al. (2014) find enduring production and income impacts for Mozambican farmers receiving a subsidy two years in a row, but the impacts seem to decay afterwards. Another study shows little impact on maize production even one year after Malawian farmers graduated from

the subsidy program following three years of participation (Ricker-Gilbert and Jayne, 2017). Studies examining ISPs' effects on grain prices usually find either insignificant or small impacts. In some cases, even if the production effect of ISPs is measurably large, it may not be large enough to totally displace cereal imports, so most of the country remains at import parity price levels (e.g., Ricker-Gilbert et al., 2013). Among the studies analyzing ISP effects on local food prices or wage rates, most found either small or non-existent impacts.

In short, while it seems feasible to design smart subsidies on paper, the well-designed features of the recent wave of ISPs in Africa have frequently been watered down or overturned during implementation. The summarized evidence underscores Chinsinga's (2012) argument that ISPs' effectiveness cannot be considered in isolation of the institutional, political, and cultural contexts in which they are applied.

6.2. Implications for ISPs moving forward

Despite the challenges outlined in this review, public popularity and the fact that ISPs benefit some who are likely to lobby for their continuation likely mean that input subsidies will continue in some form for the foreseeable future. That said, there appears to be waning political enthusiasm for ISPs in their present form. ISPs in Malawi, Nigeria, Tanzania, and Ghana have been at least temporarily discontinued or significantly downsized in recent years, often because governments have been unable to commit funds to continue the programs after external funding ended. Zambia has announced its intention to transition its ISP in 2017 to a flexible e-voucher program that allows farmers to choose from a wide range of subsidized inputs, and other national governments have begun discussing additional reform options. For these reasons, now could be an auspicious time to consider cost-effective reforms or alternatives to second generation ISPs. There may even be scope to design ISPs such that they promote sustainable intensification and support smallholder farmers' resilience to climate change rather than encourage cereal monocropping and continuous cultivation, which may exacerbate vulnerability to climate change as some current ISPs inadvertently do (Jayne et al., 2018). While further research is needed to identify how ISPs might effectively encourage climate smart agricultural practices, options include: (i) offering farmers subsidies *conditional* on their adoption of such practices; or (ii) subsidizing inputs that can directly contribute to sustainable intensification or resilience such as legume seed and drought tolerant varieties of maize seed. Beyond these possibilities, there remains considerable unexploited potential for ISPs to achieve in practice some of the potential benefits of "smart subsidy programs".

6.2.1. Improving targeting

First, we can acknowledge appropriate targeting criteria are difficult to define because they depend on program objectives, which are variously articulated in Africa. Explicit identification of goals and targets would be a tractable starting point for improvement. Transparent targeting would be useful, but better still would be outward efforts to help populations understand their government's goals. Beyond clarity on objectives, it would be prudent to acknowledge that many difficulties will be unavoidable. There are options, each with its own drawbacks.

Even with greater clarity regarding whom to target, effective targeting will still be expensive. There are few good examples to draw from to estimate what the full cost might actually be, including the costs borne by local extension services and administrative units, which are often not included in official estimates of program costs. Decentralized targeting may be attractive because of reduced costs associated with tapping local knowledge. However, it would be naïve to ignore the challenges that also exist in local political systems, and it is not clear that relying on village-level targeting improves the distribution of recipients (e.g., Pan and Christiaensen, 2012; Houssou and Zeller, 2011). Another potential targeting approach would be to use proxy means tests (Houssou and Zeller, 2011; Dorward and Chirwa,

2013; Kilic et al., 2015).¹⁸ While more research is needed, work by Houssou and Zeller (2011) suggests that proxy means tests-based targeting would be a more accurate (i.e., would result in fewer errors of inclusion and exclusion) and cost-effective approach for targeting Malawi's FISP than the community-based targeting mechanisms that are currently used. Alternatively, universal subsidy programs as seen in much of Asia should entail lower targeting costs but potentially much higher total costs because large volumes of fertilizer must be injected onto the market to appreciably reduce input prices. Moreover, the benefits of universal subsidies are concentrated amongst those best able to afford the inputs.

Geographic targeting presents a fourth option that could minimize crowding out by avoiding areas where private sector input markets are already active. Focusing on specific areas could also reap some of the benefits of a targeted ISP by concentrating efforts in poorer areas. Of course, one must then consider *why* the private sector has not been active in these areas. If the reason is poverty-constrained effective demand, subsidies may be a viable economic growth strategy. If the reason is that low response rates render fertilizer use unprofitable, input subsidies are, at best, short-term solutions to a long-term problem, and probably not a cost-effective tool for sustainably reducing poverty or increasing production. In such cases, alternative strategies that identify and help farmers adopt appropriate technologies and practices that promote sustainable forms of intensification and higher crop response rates to fertilizer may be the more appropriate starting point.

6.2.2. Alternative subsidies

Flexible input subsidy programs focusing on new inputs and practices (e.g., lime in areas where soil acidity currently impedes the profitability of basal fertilizer) could eventually lead to conditions where inorganic fertilizers could be profitably introduced into farming systems once other agronomic constraints have been addressed. If high transfer costs are the factor driving down profitability, alternative strategies (e.g., infrastructure investments) have often been shown to be more effective than fertilizer subsidies at stimulating agricultural growth and poverty reduction (Fan et al., 2008; Economist Intelligence Unit, 2008).

Additionally, a subsidy program could employ the private sector, rather than supplanting it. While a publicized feature of many second generation ISPs has been to engage the private sector, surprisingly few have done this in practice. The most promising such option is voucher-based ISPs where the vouchers are redeemable at private agrodealers. But these have potential drawbacks as well: voucher programs remain vulnerable to diversion (of vouchers), and relying on the private sector *does* come with the risk of leaving behind those underserved by the private sector. This brings us back to the question of *why* the private sector is not active in some places, and whether other strategies may better serve long term goals.

6.2.3. Non-subsidy alternatives

Perhaps the most important implication of this review is regarding complementary actions that may increase returns to ISPs. At subsidized costs or otherwise, farmers are likely to demand more fertilizer if crop response to fertilizer is higher. This will require greater public investment in effective agricultural research, development, and extension emphasizing bi-directional learning between farmers and information providers such as extension workers and researchers to adapt recommendations for inputs and management practices to local agro-ecological conditions (Snapp et al., 2015). At present, heavy spending on ISPs crowds out government expenditures on such efforts (Ghins

¹⁸ Proxy means tests identify targeted transfer beneficiaries based on a small number of readily observable and verifiable indicators that are highly correlated with more complex outcomes that would require intensive data collection efforts, such as household incomes or consumption expenditures (Houssou and Zeller, 2011).

et al., 2017).

Variations in crop response to fertilizer application are primarily due to variation in soil and farm management. Examples include timeliness of planting, row spacing, seed spacing, intercropping and crop rotations, soil pH management, recycling organic matter, use of appropriate fertilizer types and periodic soil testing, appropriate fertilizer application rates and timeliness, weeding, drainage or terracing, and conservation farming techniques like planting basins, ripping, and mulching. Not all of these practices/technologies will be feasible for resource-constrained farmers. Understanding feasibility will be the product of bi-directional learning programs to fit different conditions. There is currently a dearth of information on the profitability of various soil-crop-fertilizer combinations in different contexts. As such, it is difficult for researchers and extension agents to provide guidance to farmers that is specific to their context.

The contribution of ISPs and fertilizer use more broadly to productivity growth could be much greater if it were part of a more holistic strategy that considers agro-ecological differences, extension, and directly addresses the transfer costs of inputs. Specific interventions could include area-specific recommendations, which would require best practice research. Diagnostic trials could be used to develop best bet soil management practices, which could then be fed into local extension services and refined by farmers with the aim of improving both soil fertility and the agronomic efficiency of fertilizer use. Use of locally available organic resources (e.g., organic manure from commercial livestock and poultry operations) might also be a viable strategy.

Updating and distributing soils maps that depict soil functional properties rather soil taxonomic class is another very-low-cost option. In Zambia, for example, government soil maps are based on roughly 300 samples collected more than 30 years ago (Mambo and Phiri, 2003). Meanwhile, the data used in Burke et al. (2017) entailed collecting and analyzing more than 1700 samples in 2012 with a marginal budget of less than \$50,000 over normal survey costs. Even more cost-effective techniques are now available for soil sample collection and analysis. Building capacity for soil testing services for rural farmers themselves could help them dramatically improve their knowledge of how to manage their soils.

Of course, the fertilizer itself could also be improved, and on-going efforts to identify how to reduce potential problems associated with fertilizer quality and product adulteration could be beneficial. This is important to ensure that farmers access fertilizers with accurately specified nutrient content.

6.2.4. Policy coherence

Finally, seemingly unrelated policies may have unintended adverse consequences on governments' efforts to promote fertilizer use. For example, police checkpoints and road taxes increase (decrease) farm-gate fertilizer (crop) prices in surplus-producing areas. These taxes reduce the incentives of farmers in such areas to use fertilizer. In another example, Tanzania has many redundant agencies mandated with controlling fertilizer imports. These include the Tanzania Fertilizer Regulatory Authority, Weight and Measures Authority, Radiation Commission, Chief Government Chemist, and the Tanzania Bureau of Standards. This multiplicity of bodies means multiple fees that are inevitably passed on to farmers. Faced with rising subsidy costs and constrained budgets, it is crucial that governments examine alternative options and strategies to reduce costs along the fertilizer value chain, including burdensome regulations, charges, and taxes that add to farm-gate prices.

Yet another example is that many countries that subsidize fertilizer to make food more available also subsidize the output price of grains, making them more expensive. On paper, each of these policies seems designed to benefit farmers who are either producers or consumers of grain. In practice, most African farmers are both producers and consumers of grain, so these policies have partially offsetting effects.

6.3. Closing remarks

It is widely recognized that increased fertilizer use is a necessary condition for sustainable agricultural intensification in Africa. Fertilizer subsidy programs have contributed to raising fertilizer use at least in the short-run. However, the empirical record is increasingly clear that improved seed and fertilizer are not sufficient to achieve profitable, productive, and sustainable farming systems in most parts of Africa. Sustainable soil and moisture management practices and complementary inputs tailored to specific micro-environments are often required to make the seed and fertilizer package profitable and sustainable (Otsuka and Muraoka, 2017). For these reasons, it is increasingly apparent that second generation African ISPs have given too much attention to giving fertilizer to farmers and too little attention to enabling them to use it efficiently and profitably. Going forward, a much more holistic approach is needed in most instances to sustainably raise agricultural productivity in Africa. The benefits of future ISPs may be improved by exploring innovative means to encourage the use of complementary inputs and management practices in addition to greater use of inorganic fertilizers.

Acknowledgements

This work was supported by the World Bank, the Bill and Melinda Gates Foundation under the Guiding Investments in Sustainable Agricultural Intensification Grant (OPP1039151), the US Agency for International Development (USAID) Bureau for Food Security under the Food Security Policy Innovation Lab [AID-OAA-L-13-00001], and the USAID Missions to Zambia [grant number 611-A-00-11-00001-00] and Kenya [grant number AID-623-A-12-00022]. The authors appreciate the helpful comments and insights received from Aparajita Goyal, Asfaw Lemma, Saweda Liverpool-Tasie, Athur Mabiso, David Mather, Isaac Minde, Milu Muyanga, John Nash, David Nyange, John Olwande, Karl Pauw, Shahidur Rashid, Danielle Resnick, Jake Ricker-Gilbert, Nicholas Sitko, Hiro Takeshima, and Veronique Theriault, and research assistance from Aakanksha Melkani.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.foodpol.2018.01.003>.

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