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IFPRI Discussion Paper 01304

December 2013

Fertilizer in Ethiopia

An Assessment of Policies, Value Chain, and Profitability

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ABSTRACT

Fertilizer use in Ethiopia has almost quintupled since the official elimination of input subsidy programs. Yet, application rates remain far below recommended level and, given limited scope for area expansion, fertilizer promotion continues to be the central focus for enhancing agricultural productivity. Unlike many other developing countries, Ethiopia has moved from partial liberalization in 1990s to government monopoly control over imports, with exclusive marketing through farmers' organizations, since 2008. In 2010, the government embarked on a new policy initiative, the Growth and Transformation Program, which sets annual production targets for cereals by regions. In line with the objectives of this program, government increased fertilizer imports from 440 thousand tons in 2008 to about 890 thousand in 2012. However, fertilizer availability (import plus change in stocks) far exceeded total consumption resulting in large carryover stocks reaching almost half a million tons—worth roughly US$350 million—sitting in the cooperative warehouses throughout the country in 2012. This is the context in which the Ethiopian Agricultural Transformation Agency requested IFPRI to undertake a study analyzing policies, the value chain constraints, profitability of fertilizer, and opportunities for further expansion of fertilizer use.

The study involved interviewing a large number of stakeholders in fertilizer value chain, collection of data on costs and margins from the key actors in the value chain, as well as household survey data. In this paper, we present the key findings from that study. In particular, the paper presents estimates of detail costs and margins in the value chain, econometrically derived profitability and yield responses, and the costs of government's fertilizer promotion policies. Based the estimates of the costs and margins in the fertilizer value chain, the study argues that the current value chain will not be sustainable unless the scale of operation, as well institutional capacity, of the primary cooperatives goes up. The estimates of profitability suggest that fertilizer use in major cereals is profitable, irrespective of the method of calculation/estimation, implying that recent challenge with carryover stock reflects the institutional and value chain constraints. With regards of program costs, this study finds that while there is no official subsidy program, fertilizer promotion has involved large fiscal costs—estimated at US$40 million per year since 2008. Finally, for further expansion of fertilizer use, the study makes two recommendations: (a) allowing private sector to participate in the domestic markets alongside cooperatives; and (b) paying more attention to other cereals—such as barley and sorghum—where fertilizer use is close to zero.

Keywords: fertilizers, value-chain analysis, yield response, profitability

ACKNOWLEDGMENTS

The authors are thankful to the Bill and Melinda Gates Foundation for financial support; to the USAID-CIAFS for supporting Gezahegn Ayele's time; to the markets program director at the Ethiopian Agricultural Transformation Agency (ATA), Nega Wubeneh, for sharing his insights and following up with the government; and to Paul Collett for commenting on earlier versions. Our special thanks to Khalid Bomb, the chief executive officer of the Ethiopian ATA, for his continuous support and to Ato Teshome, the director of planning at the Ministry of Agriculture, for sharing data and responding to numerous queries. Finally, we would like to thank Solomon Lemma and Gashaw Abate for their excellent assistance with data collection and the survey works. The authors take the responsibility of any errors or omissions.

1. INTRODUCTION

Agricultural productivity growth has been at the center of Ethiopia's development strategies since the country began the Agricultural Development Led Industrialization program in the early 1990s. The country has consistently allocated more than 10 percent of public spending on agriculture in the past 10 years (Fan, Babatunde, and Lambert 2009; World Bank 2010a), has invested heavily in rural infrastructure (Mogues, Ayele, and Paulos 2008), and has made concerted efforts toward agricultural intensification with special attention to the promotion of extension services and fertilizer use (Byerlee et al. 2007). Available data suggest that these policies have paid off in terms of both poverty reduction and overall growth performance (Dorosh and Rashid 2013).[1] The growth in fertilizer use has been remarkable. In more than two decades following the introduction of fertilizer under the *Freedom from Hunger* program in the late 1960s, fertilizer use grew from 3,500 tons[2] in the early 1970s to only about 34,000 tons in 1985. In contrast, it grew from 140,000 tons in the early 1990s to about 650,000 tons in 2012.

The growth in fertilizer use was triggered by the market liberalization programs in the 1990s. Since then fertilizer promotion has involved several policy changes, ranging from liberalization, with both public- and private-sector participation, to government monopoly control over imports with exclusive marketing through farmers' cooperatives in 2008. After the input marketing parastatal, the Agricultural Input Supplies Enterprise (AISE), obtained monopoly control over imports, the government of Ethiopia adopted some ambitious policies to enhance agricultural productivity. The most visible policies include setting up specialized programs, such as the Agricultural Growth Program, Growth and Transformation Program, and the Agricultural Transformation Agency. The recent impetus for increasing fertilizer use has been largely driven by the Growth and Transformation Program, which sets annual cereal production targets for each region. Increasing the distribution of chemical fertilizer and improved seed has been the key move for achieving these targets. A clear manifestation of this strategy is the sharp increase in fertilizer imports, which jumped from 440,000 tons in 2008 to 890,000 tons in 2012. However, fertilizer availability (import plus change in stocks) far exceeded total use, resulting in large carry-over stocks reaching almost half a million tons in 2012—worth roughly US$350 million[3]—sitting idly in cooperative warehouses throughout the country.

Yet, fertilizer use in the country is low. Only 30–40 percent of Ethiopian smallholders use fertilizer, and those who do apply on average only 37–40 kilogram per hectare (ha), significantly below recommended rates (Spielman, Alemu, and Kelemwork 2013). Therefore, the growing problem with carry-over stocks implies a mismatch between the government's targets and the effective demand of fertilizer under the current policies, infrastructure, and institutions. This is the context in which IFPRI was requested by the Agricultural Transformation Agency to undertake a study assessing the policies, profitability, and performance of the value chain. This paper presents key findings from that study.

The rest of the paper is organized as follows. After providing a brief overview of the policy evolution in the next section, we discuss the estimated margins and cost buildups in the fertilizer value chain in Section 3. Section 4 assesses the costs and sustainability of the current fertilizer promotion policies. A key finding from this analysis is that, while government did not have an official subsidy program, implementation of fertilizer promotion policies involved large fiscal costs, which we will refer to as implicit costs.[4] Results of the yield response and profitability of fertilizer are presented in Section 5, and the paper concludes with a summary and implications of the key results.

[1] For example, Dercon, Hill, and Zeitlin (2009, 9) argue that agricultural growth alone cannot generate sufficient domestic demand to prevent prices from falling, which can put a break on further growth. However, Dorosh and Rashid (2013) argue that agricultural growth made a major contribution in the country's overall growth performance, which accelerated 1.3 percent in the 1980s to 2.9 percent in the 1990s and to 6.2 percent from 2000 to 2010.

[2] All tons used in the paper refer to metric tons

[3] All dollar amounts are given in US dollars.

[4] We call these implicit costs because these costs are absorbed by the relevant agencies involved in the fertilizer marketing and distribution and not shown as a subsidy in the government's book.

2. AN OVERVIEW OF THE FERTILIZER SUBSECTOR IN ETHIOPIA

The Policy Evolution

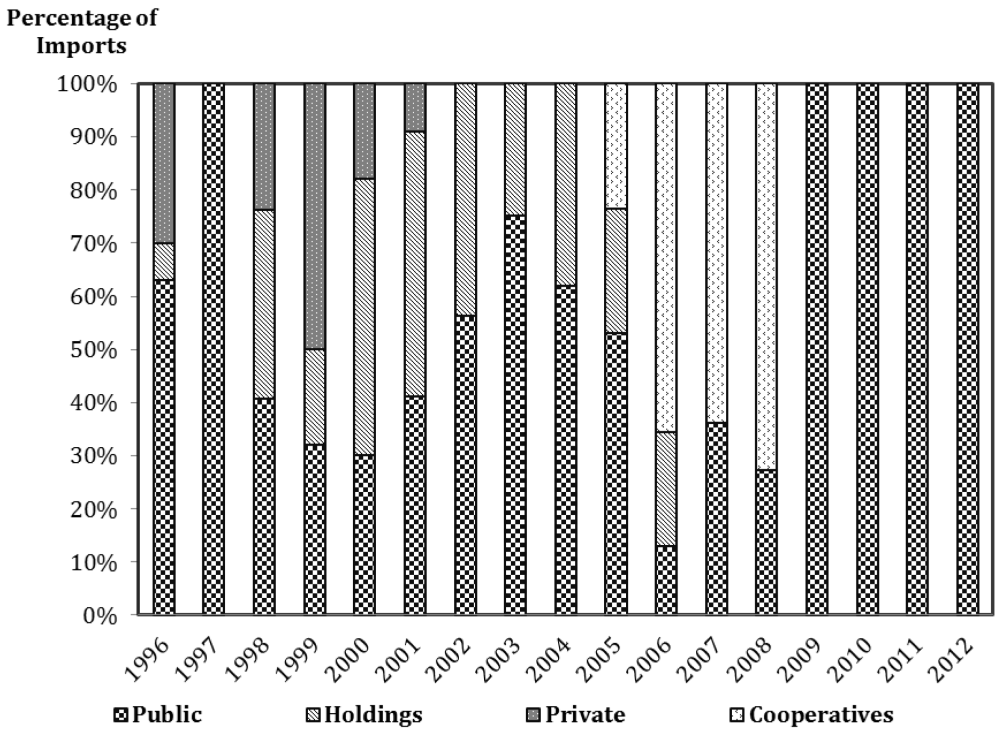
From the early days of field level demonstration to the collapse of central planning in 1991, fertilizer markets in Ethiopia have been controlled by the government through its input marketing agency, called Agricultural Input Supplies Corporation, later renamed as Agricultural Input Supplies Enterprise in 1992. This agency had its own marketing network throughout the country, which included marketing centers and service cooperatives for distributing fertilizers to the farmers. As in many other African countries, Agricultural Input Supplies Corporation's controlled marketing was inefficient, involved large direct subsidies, and incurred large administrative costs.

In the new marketing system introduced in 1992, the transitional government articulated its desire to end government monopoly as part of its overall market liberalization policies. The private-sector entry, however, was slow in the early years: Only one private company (Ethiopian Amalgamated Limited) actively participated in fertilizer marketing up until 1996. Subsequently, three other companies entered into the markets and attempted to develop their own marketing network. Around this time, a new breed of companies, owned by the regional governments, started to flourish. The first such company to enter was Ambassel Trading, a private limited company owned by the Amhara regional government. In the initial years, until 1995, Ambassel worked mainly as an agent to AISE, but it began importing in 1996 and started serving as the sole distributor and wholesaler of AISE in the Amhara region.

Inspired by Ambassel, other regional governments started launching their own companies. By 1998, companies of all four major grain-producing regions in the country were importing and distributing fertilizers alongside AISE and four private companies.[5] However, competition among government, private, and holding companies was short lived. Shares of private companies in total fertilizer imports dropped from 28 percent in 1996 to zero in 2002 (Figure 2.1). It is commonly argued that the indirect support of the government to holding companies made it difficult for the private sector to operate profitably (DSA 2006; Byerlee et al. 2007). One of the earlier studies (Demeke et al. 1998) provides some specific examples of how holding companies received support from the government. The study reported that in Amhara, the regional holding company Ambassel enjoyed larger market shares due to policy privileges of being the sole agent of AISE, because farmers who received fertilizer credits from the government were not allowed to purchase from private companies. However, several arguments counter this position. For instance, it was widely known that the fertilizer market in Ethiopia is thin and opportunity costs of private-sector capital in this market can be high; so the private sector might find it more profitable to invest elsewhere in the rapidly expanding economy than in the perilous fertilizer market (Rashid and Ayele 2009).

[5] Dinsho in Oromia; Wondo in the Southern Nations, Nationalities, and Peoples' Region, SNNP and Guna in Tigray.

Figure 2.1 Distribution of fertilizer imports by importer types, 1995–2012



Source: Ethiopia, MoA (various years).

Cooperatives have been involved in input marketing in Ethiopia since the 1970s, but they were never involved in imports until recently. In the new millennium the government adopted a strategy to develop an input marketing system with strong participation of farmers' organizations. The initiative was welcomed because it was also one of the policy prescriptions emerging from the development partners for addressing the problems of thin markets and product aggregation problems.[6] This was an aggressive strategy, and the cooperatives' market share grew rapidly, reaching almost 75 percent of the total fertilizer use in 2007/2008 (Figure 2.1). This rapid growth was promoted by providing subsidized credits to the cooperative unions to import and distribute fertilizer. However, the policy faced problems due to the rising cost of fertilizer and a balance of payment problems during 2007/2008. The government requested financial support from its development partners for and managed to receive $250 million from the World Bank and another fund worth 100,000 tons of fertilizer from the African Development Bank. Through some negotiations, the government and the two banks agreed to coordinate all fertilizer imports through AISE. This policy decision resulted in withdrawal of all holding companies except Wondo from fertilizer markets in Ethiopia (World Bank 2009).

Fertilizer Use Patterns

Chemical fertilizer is primarily used in cereal production in Ethiopia. According to Ministry of Agriculture and Rural Development (MoARD) statistics, cereals account for 90 percent of the country's total chemical fertilizer application; and during 2005/2006–2010/2011, only two regions, Oromia and Amhara, accounted for 70 percent of total use, with Oromia alone accounting for about 40 percent. The shares of the other two major cereal-growing regions— the Southern Nations, Nationalities, and Peoples' Region (SNNPR) and Tigray—were 10 and 3 percent, respectively.

[6] See Morris et al. (2007).

Detail estimates of planted area and fertilized area from the Central Statistical Agency's Agricultural Sample Surveys are reported in Table 2.1. Although the Central Statistical Agency collects data on the use of organic fertilizer, we have considered only urea and diammonium phosphate (DAP) because they are the two main types of fertilizers used in Ethiopia. Three obvious trends can be observed in the table. First, there is an increasing trend in both planted area and fertilized area. While planted area has increased from about 7.0 million ha in 2003/04 to 9.7 million ha in 2010, representing a 38.6 percent growth, fertilized area has more than doubled from 1.12 million ha to 2.31 million ha during the same time. Second, more teff area appears to receive fertilizer than any other cereal crops, in all regions except SNNPR. At the national level, teff has consistently accounted for more than 40 percent of fertilized land. In 2010/11, of the total fertilized area of 2.31 million ha, 981,000 ha were allocated to teff, which is almost 75 percent more than maize or wheat. It may seem counterintuitive that farmers are using more fertilizer in a low-yielding crop like teff. However, this is consistent with the fact that teff prices have been increasing in real terms for many years. As a result, price has become more favorable relatively for teff than for other cereals. In addition, due to ease of storage and long shelf life, farmers attach some intrinsic values to teff.

Table 2.1 Planted and fertilized area (in thousands of hectares) by region and by crop, 2000/2001–2010/2011

Region	Crops	2003/2004			2007/2008			2010/2011		
		Planted	Fertilized	% Fertilized	Planted	Fertilized	% Fertilized	Planted	Fertilized	% Fertilized
Amhara	**Cereal**	**2,402**	**345**	**14.4**	**2,923**	**646**	**22.1**	**3,271**	**925**	**28.3**
	Maize	258	82	31.8	397	168	42.29	472	241	51.1
	Wheat	333	94	28.3	427	154	36.2	499	243	48.7
	Teff	826	144	17.4	1,047	292	27.9	1,014	387	38.2
	Others	985	25	2.6	1,052	31	3.0	1,286	54	4.2
Oromia	**Cereal**	**3,168**	**583**	**18.4**	**4,052**	**771**	**19.0**	**4,576**	**961**	**21.0**
	Maize	786	150	19.0	969	151	15.6	1,109	249	22.5
	Wheat	556	138	24.8	769	240	31.2	816	217	26.6
	Teff	820	238	29.1	1,083	345	31.9	1,289	447	34.6
	Others	1,006	57	5.7	1,231	35	2.8	1,362	48	3.5
SNNPR	**Cereal**	**688**	**72**	**10.4**	**785**	**92**	**11.7**	**857**	**191**	**22.3**
	Maize	216	17	8.1	249	38	15.2	237	55	23.0
	Wheat	115	28	24.1	119	26	22.1	131	47	35.9
	Teff	183	23	12.6	235	24	10.0	265	76	28.8
	Others	174	4	2.1	183	4	2.3	224	13	5.9
Other	**Cereal**	**741**	**130**	**17.6**	**970**	**141**	**14.5**	**986**	**233**	**23.7**
	Maize	106	11	10.7	152	13	8.8	144	20	14.0
	Wheat	95	29	30.9	111	26	23.9	107	49	45.8
	Teff	160	54	33.8	200	58	28.7	192	71	37.1
	Others	380	35	9.3	507	44	8.6	542	93	17.1
National	**Cereal**	**6,999**	**1,130**	**16.1**	**8,730**	**1,649**	**18.9**	**9,691**	**2,310**	**23.8**
	Maize	1,367	260	19.0	1,767	371	21.0	1,963	565	28.8
	Wheat	1,099	289	26.3	1,425	447	31.4	1,553	556	35.8
	Teff	1,989	459	23.1	2,565	718	28.0	2,761	981	35.5
	Others	2,544	122	4.8	2,973	114	3.8	3,413	207	6.1

Source: Authors' calculations based on Central Statistical Agency (CSA) data.

Note: DAP = diammonium phosphate; SNNPR = Southern Nations, Nationalities, and Peoples' Region. The figures include only DAP and urea, which CSA has been reporting separately from other organic fertilizer since 2003/2004.

Finally, fertilizer use in other cereals (for example, barley, sorghum, rice, and millet) is miniscule relative to the three major cereals and the land allocated to them. Since 2003/04, about 2.6 million ha, equivalent to 35 percent of total planted land, has been allocated to these cereals; but only about 4 percent of this land is fertilized. Furthermore, in high-potential regions of Amhara and Oromia, the share is even smaller—of the 1.9 million ha allocated to these crops, only 102,000 ha are fertilized. Since these crops are nontradable and account for smaller share of domestic consumption, the economics of fertilizer use in other cereals has not been favorable. However, some concerted policy efforts have been made to change that in the coming years, especially for barley and rice. The Ethiopian government has been able to attract two large brewing companies from Europe, Heineken and Diageo, to set up their brewing plants in Ethiopia. Heineken will now have the largest brewing plant in Ethiopia and recently signed a Memorandum of Understanding with the government to develop the barley value chain (Tadele 2013). The Diageo, which acquired a local brewery (Meta Brewery) for $250 million, also has signed a Memorandum of Understanding and plans to procure barley locally through contract farming, which is now grown on about a million ha of land. On the other hand, the government of Japan is supporting promotion of rice in Ethiopia, under which the rice-growing area is expected to increase from 156,000 ha in 2009 to 463,000 ha by 2014 and 774,000 ha by 2019 (Ethiopia, MoARD 2010). Under this strategy, irrigated land is expected to almost triple from 26,000 ha to 78,000 ha by 2014 and then grow to 775,000 ha by 2019 (Assefa, Alemu, and Shirator 2011). If these initiatives are successful, fertilizer use in Ethiopia will substantially increase in the coming years.

In examining future potentials in fertilizer use and productivity enhancement, another way to look at fertilizer application is by combining it with modern input use. We used the 2008 Ethiopian Agricultural Household and Marketing Survey (EAHMS) to do the analysis.[7] The results are presented in Table 2.2, which shows that fertilizer use estimates are roughly similar to the national statistics reported earlier. In the four major cereal production regions, about 37 percent of the cereal-growing farmers apply fertilizer, with Amhara region leading the way at about 50 percent. About one-third of the cereal-growing farmers in Oromia and SNNPR use fertilizer, but only about 22 percent do so in Tigray. When it comes to application of purchased modern seeds, the estimates are somewhat disappointing; with the exception of the Amhara region and that of the maize crops, basically the use of modern seeds is very limited in Ethiopia. However, as Spielman et al. (2011) point out, these numbers somewhat mask the actual use of improved seed because they do not account for the use of saved seed from improved open-pollinated varieties by the farmers. In an ideal farming condition, farmers should use fertilizer and improved seeds together to achieve optimal returns. However, our estimate of improved seed use is very low at 6.6 percent (Table 2.2). The main reasons for this low estimate are (a) open-pollinated varietiey seed for wheat is often saved by farmers and not treated as a modern variety; (b) until recently there was no high yeilding varieties of teff; and (c) when asked about improved seeds, farmers often report only the ones they buy from the government agencies.

[7] The Ethiopian Agricultural Household and Marketing Surveys (EAHMS) was conducted by IFPRI in collaboration with the Ethiopian Development Research Institute (EDRI) in 2008. The survey included about 2,000 households and represented all four cereal-growing regions in the country. The detail of the sampling and survey is available online from a technical publication by the Joint Research Center of the European Commission at http://bookshop.europa.eu/en/cereals-availability-study-in-ethiopia-2008-pbLBNA24801/.

Table 2.2 Use of fertilizer, improved seeds, and their combinations, *meher* season, 2007/2008

Use/Region	Teff	Barley	Wheat	Maize	Sorghum	All cereals
(percent of households)						
Fertilizer use						
All regions	58.00	31.60	55.50	33.10	6.40	36.92
Tigray	28.30	25.90	36.70	9.30	9.30	21.90
Amhara	77.30	41.60	57.70	63.50	10.70	50.16
Oromia	53.30	25.20	56.80	19.30	3.40	31.60
SNNPR	51.10	18.00	64.10	21.40	7.00	32.32
Improved seed use						
All regions	4.30	0.50	8.30	23.70	0.40	7.44
Tigray	3.90	0.00	18.40	2.10	1.30	5.14
Amhara	2.30	0.70	2.20	54.40	0.80	12.08
Oromia	3.90	0.00	9.80	9.90	0.00	4.72
SNNPR	9.30	1.40	8.00	9.80	0.00	5.70
Both fertilizer and improved seed						
All regions	3.80	0.30	7.10	21.60	0.20	6.60
Tigray	1.30	0.00	12.20	2.10	0.00	3.12
Amhara	2.30	0.70	2.20	51.80	0.80	11.56
Oromia	3.60	0.00	9.30	7.80	0.00	4.14
SNNPR	8.50	0.00	6.40	8.50	0.00	4.68

Source: Authors' calculations using EAHMS (2008) survey data.
Notes: SNNPR = Southern Nations, Nationalities, and Peoples' Region.

There are problems in the seed system as well (Byerlee et al. 2007; Alemu, Tripp, and Rashid 2010). The problem is particularly acute in the case of hybrid maize seed shortage,which has become a national concern as farmers are unable to access seed in the quantities that they demand. This has resulted from constraints faced by both public- and private-sector operations, with the public sector accounting for 60 percent of hybrid maize seed production and the private sector accounting for the remaining 40 percent (Alemu, Tripp, and Rashid 2010). Markets for self-pollinated varieties also face problems. Farmers perceive insignificant advantage from seed in mass production over farmer-saved or locally traded seed, and hence farmers have little incentive to purchase open-pollinated variety seed from the market. Furthermore, production of self-pollinated seed is a loss-making enterprise for the public system, so the private-sector companies have incentives to invest. These problems are well recognized by the government, and several initiatives are under way to address problems in the country's seed system.[8] If they succeed, these programs will provide a further boost to fertilizer use in Ethiopia.

[8] For details, visit www.ata.gov.et/programs/system-programs/seeds/.

3. FERTILIZER VALUE CHAIN

Key Actors and Decisionmaking Process

The fertilizer value chain in Ethiopia involves numerous actors who perform three broad sets of activities: (1) import planning, (2) import execution, and (3) marketing and distribution. The import planning begins with a demand assessment, conducted by the *woreda* (district) agricultural bureau based on primary data collected with community surveys by the extension workers, called development agents. Some primary cooperatives also conduct demand assessments. The estimates by the development agent and cooperatives are reconciled by the *woreda* bureau offices and then sent to the zonal offices. The zonal offices aggregate *woreda*-level data and then send the estimates to the Bureau of Agriculture and Rural Development (BoARD). Since the adoption of the Growth and Transformation Program in 2010, production targets set by the program over a five-year plan are also factored in when finalizing the estimates at the Bureau of Agriculture offices. Finally, the Ministry of Agriculture and Rural Development aggregates the regional estimates and comes up with the national demand estimates. The net import requirement is determined by deducting the previous year's carry-over stocks from the current year's demand.

In executing the imports, the Ministry of Agriculture (MoA) prepares tender documents and invites a consortium of public institutions (Ministry of Finance and Economic Development, National Bank of Ethiopia, Commercial Bank of Ethiopia, and Quality and Standard Control Office) to review and approve the projected demand, necessary foreign exchange requirements, and opening of international procurement tender. As indicated previously, since 2008, the execution of imports has been carried out exclusively by AISE. The logic for giving monopoly power to AISE is to take advantage of economies of scale. The idea is simple: Importing in large quantities gives a buyer more bargaining power to negotiate lower prices. In addition, large-scale imports can arguably reduce transaction costs and make value chain management more efficient. A recent MoA report argues a discount of 2–4 percent per ton could be obtained for a bulk purchase of 25,000 metric tons (mt) or more (Ethiopia, MoARD 2012). However, this is hard to validate. In 2011, several regional cooperative unions wanted to break out of AISE and requested the MoA to import fertilizer by forming a regional federation of cooperatives. The MoA, however, decided that allowing three or more cooperative federations to import would inefficient. Therefore, the AISE was nominated again as the sole importer of fertilizer on behalf of farmers' cooperative unions.

After imported fertilizer arrives at Djibouti port, the AISE informs the regional cooperative unions to transport the consignment to the central warehouses. The cooperative unions determine where to store it, depending on the storage capacity. The option given first priority is to deliver fertilizer directly from the Djibouti port to the warehouse of the cooperative unions. If the unions do not have storage capacity or are not ready to receive the shipments, AISE stocks fertilizer in its central warehouses. From central warehouses, the union distributes to the primary cooperatives, from which farmers can get direct access to buy. In regions that have no cooperative unions or are inaccessible, AISE takes the responsibility to deliver, with primary cooperatives acting as a wholesaler.

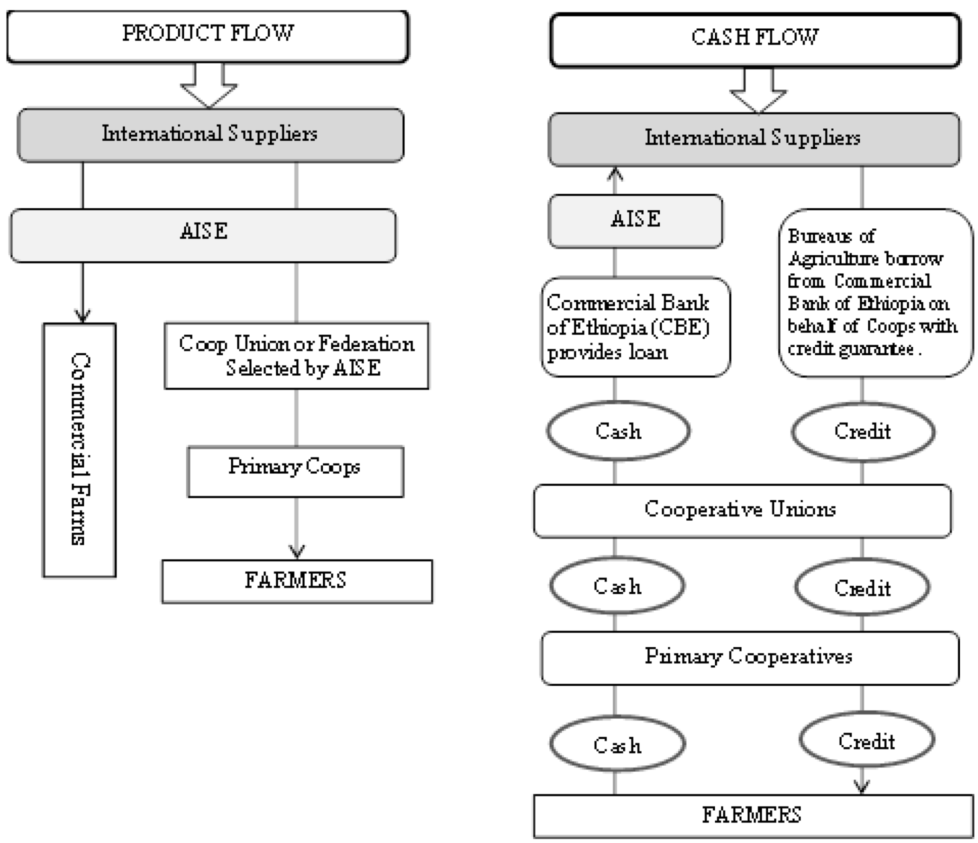
The BoARD plays an active role in the marketing and distribution of fertilizers. This includes facilitating the input credit guarantee to the Commercial Bank of Ethiopia, providing transportation facilities if needed, and ensuring on-time delivery of fertilizer. The BoARD is also involved in the determination of prices and margins. The AISE determines weighted average price of fertilizer at the central warehouse level. The BoARD then adds margins (both for unions or federations and for primary cooperatives) and determines loading and unloading costs, warehouse rent, bank interest rates, and other administrative costs. During our interview, the regional BoARD officials indicated that the price determination in each region is made in consultation with the unions.[9] In Tigray and SNNPR, price

[9] Coordination between the Bureaus of Agriculture at the regional level and cooperative unions is either through strong guidelines (in Oromia) or exchange of information (in Tigray, Amhara, and SNNPR) in fertilizer distribution to the primary cooperatives. In all regions, priority has been given to areas where the cropping season starts earlier and also to zones that are

determination is done twice a year for *meher* (the main cropping season) and *belg* (minor season in selected areas from February to May) seasons. The *meher* season prices are set by taking into account the weighted average prices of carry-over stock and compensating for storage and other administrative costs and new import. The *belg* season prices (September–April) are set using the *meher* season price plus the bank interest and administrative costs.

Figure 3.1 shows product and cash flow with all actors involved in the value chain. To import fertilizer through AISE, the regional governments offer credit guarantees for cooperative unions. The payments to AISE are processed through two installments: (1) during opening of the letter of credit, and (2) upon arrival of fertilizer at the Djibouti port. The primary cooperatives receive fertilizer on credit from unions and sell mostly in cash to smallholder farmers. However, in remote and food-insecure areas of Amhara and SNNPR, farmers can receive fertilizer with a 50 percent down payment with the understanding that the remainder be paid after the harvest. Other sources of credit include microfinance and rotating savings and credit unions. Estimates from the EAHMS survey suggest that 60 percent of the farmers borrowed money to purchase fertilizer. The long chain of money transactions has some serious problems, especially with regard to accountability and incentives. Since the BoARD provides credit guarantee, banks have no risk in lending money. However, when it comes to credit collection, the responsibility lies with the cooperatives, with which BoARD has no authority. Besides, the BoARD does not have any incentives to increase collection because the burden of defaults is shouldered by a guarantee scheme among regional governments.

Figure 3.1—Product and cash flows in Ethiopian fertilizer value chain



Source: Authors' construction based on the interviews with stakeholders and MoA officials.
Note: AISE = Agricultural Input Supplies Enterprise.

difficult to reach after the rains have started.

The Composition of Fertilizer Marketing Costs

That fertilizers are more expensive in Africa compared with developing countries in Asia is commonly known (World Bank 2006). This is because ocean freight costs in Asia are lower due to economies of scale, and domestic transport costs are much higher in Africa than in Asian countries mainly due weak infrastructure and policy environment. At the country level, a national government can do very little to influence ocean freight fees, but it can directly influence domestic transaction costs through improvements in infrastructure, institutions, and policy environment; and Ethiopia has done relatively well in reducing domestic marketing costs. In this subsection, we present both macro-level estimates and detail costs and margin analysis based on a 2012 IFPRI survey.

At the macro level, the domestic marketing costs, measured as the difference between weighted retail price and the landed costs at Djibouti, show a consistent decline over the past decade. Historical data from the Food and Agriculture Organization of the United Nations on domestic and international prices of fertilizer show that the difference between the domestic retail price and the world price of DAP has declined from $229/mt in the 1980s to $174/mt in the 1990s to $150 in the 2000–2010 decade. This is a clear reflection of overall improvement in rural infrastructure, particularly road construction and telecommunications in Ethiopia (Rashid and Negassa, 2013). The improvement in transportation infrastructure is also visible in grain marketing costs. Comparing three rounds of traders' survey data—conducted in 1996, 2002, and 2008—Rashid and Negassa (2013) report that, in real terms, transaction costs per metric ton of grain from purchase to sale declined from ETB 210 (Ethiopian birr) in 1996 to only ETB 90 in 2008, equivalent to almost a 60 percent reduction.

To gather more disaggregated information on costs and margins, IFPRI conducted a survey in 2012 in four major cereal-growing regions. The results are presented in Table 3.1, showing all 26 elements of costs in the value chain of both DAP and urea. A starting point for analyzing such a value chain table is to assess whether there is room for improving efficiency from import execution to the farm gates. We begin at the port, where AISE uses Cost, Insurance and Freight Liner Out (CIFLO) contract agreement, which sees a transfer of ownership of product when it is loaded on trucks at Djibouti port. The CIFLO prices should be equal to CIF prices at Djibouti port. However, differences are $24.20/mt for DAP and $19.20/mt for urea, which leads to an increase in fertilizer costs by about 2 percent and amounts to about $19.5 million "unallocated margins" in 2012 imports.[10] This is because the CIF price is estimated based on the Ethiopian birr equivalent international price per ton at a fixed exchange rate at the time of purchase. In 2012, at the time of placing the order, the exchange rate was fixed at ETB 18 to $1, but the actual exchange rate at the time of fertilizer purchase by farmers was about (ETB 17.40 to $1, on average). Based on the predetermined exchange rates, the AISE had set CIF prices at ETB 12,621.20 per ton for DAP and ETB 10,050.40 per ton for urea. If actual exchange rates were used, prices per metric ton would have been ETB 12,200.52 and ETB 9,716.33, respectively.

[10] The relevant unit in the AISE responded to the draft report, indicating that this unallocated margin has no personal gains. The exchange rate is fixed at a higher level to avert potential risks of devaluation. If there is no devaluation at the time of delivery, the surplus generated due to the fixing of exchange rates goes to the next year's import fund.

Table 3.1 Fertilizer cost buildups (in US$ per metric ton), by region, 2012

	Cost element	Tigray		Amhara		Oromia		SNNPR	
		DAP	Urea	DAP	Urea	DAP	Urea	DAP	Urea
	CFR ex Djibouti	**701.2**	**558.4**	**701.2**	**558.4**	**701.2**	**558.4**	**701.2**	**558.4**
CFR local price due to fixed exchange rates		725.4	577.6	725.4	577.6	725.4	577.6	725.4	577.6
	Margin due exchange rate differentials	24.2	19.2	24.2	19.2	24.2	19.2	24.2	19.2
1	Insurance	1.4	1.1	1.4	1.1	1.4	1.1	1.5	1.2
2	Clearing and transit	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
3	Bank charge/ commission for LC	9.4	7.8	9.4	7.8	9.4	7.8	9.5	7.6
4	Inspection and bagging (0.2 % on c. & f.)	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2
5	Rebagging	0	0	0	0	0	0	0	0
6	Overhead cost/profit margin for AISE	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	Bank interest	—	—	—	—	—	—	0.1	0.1
8	Spoilage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	Transport (Djibouti to central warehouse)	63.6	63.6	62.8	62.8	51.4	51.4	51.3	51.3
	AISE Price at central warehouse	**805.2**	**655.3**	**804.4**	**654.4**	**792.9**	**643**	**793.2**	**642.8**
11	*Unloading & loading at central warehouse*	1.7	1.7	2.3	2.3	2.3	2.3	2.3	2.3
12	Warehouse rents	1.6	1.6	2.6	2.6	3.4	3.4	2.3	2.3
13	Rebagging	—	—	0.1	0.1	0.1	0.1	0.3	0.3
14	Profit margins for federation/union***	1.7	1.7	—	—	—	—	1.1	1.1
15	Profit margin for unions	—	—	1.7	1.7	0.9	0.9	1.7	1.7
16	Bank service charge	—	—	0.6	0.6	3.2	2.5	—	—
17	Receipt printing	—	—	—	—	—	—	0.6	0.6
18	Administrative cost	5.2	5.2	—	—	2.3	2.3	—	—
19	Insurance	—	—	—	—	1.1	0.9	—	—
20	Inventory	—	—	—	—	0.2	0.2	—	—
	Union Price	**815.4**	**665.5**	**811.7**	**661.7**	**806.4**	**655.4**	**801.5**	**651.1**
21	Margin (subsidy due to carry-over stock)			–24.4	–31.5	–7.1	–24		
22	Transport cost from central warehouse to cooperatives (per ton)	28.5	28.5	33.6	33.6	18.7	18.7	33.9	33.9
23	Profit margin for primary cooperatives	1.7	1.7	1.4	1.4	1.7	1.7	1.7	1.7
24	Primary cooperatives administrative cost	5.2	5.2	3.2	3.2	2.6	2.6	2.9	2.9
25	Unloading at the primary cooperatives	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
26	Bank interest (4.01%) for 4 months	11.1	9.1	11.1	9.0	11.0	9.0	11.0	8.9
	IPP at primary cooperatives	**864**	**712**	**838**	**679**	**835**	**665**	**853**	**700**
	Farmers purchase at price	***864***	***712***	***814***	***648***	***828***	***641***	***853***	***700***
Difference between farmgate and landed cost		138	134	113	102	110	87	127	123
Transport costs as % of farmgate price		67%	69%	70%	72%	64%	80%	67%	69%

Source: Authors' calculation based on the information from the Ethiopia MoA, AISE, and the cooperative unions.

Notes: CFR= Cost Freight Rate; DAP = diammonium phosphate; SNNPR = Southern Nations, Nationalities, and Peoples' Region AISE=Agricultural Inputs Supply Enterprise; c. &f. =cost and freight; LC=Letter of Content; IPP= Import Parity Price.

The AISE supplies from port to central warehouses at strategic locations in the country. The cost buildup, however, is based on specific warehouses with relatively larger volume of operations in each zone or region. The following warehouses are considered: Nazerth and Shashemene for the SNNPR ; Nazerth and Bahir-Dar for Amhara region; Addis Ababa, Nazerth, Modjo, and Debre Zeit for Oromia region; and Mekele for Tigray region. The hand-over prices at these central warehouses are determined by the AISE, which is the sum of the weighted average of CIF prices at Djibouti and the transport cost adjusted according to the distance from the port, cost of insurance, clearing and transit, bank commission, inspection, bagging and rebagging, unloading cost at the central warehouse, and overhead.

The regional bureaus determine fertilizer prices for unions and primary cooperatives based on AISE hand-over prices and savings (losses) from the carry-over stocks. The additional costs include transport cost, profit margins and administrative cost for cooperatives, bank interest, warehouse rent, as well as loading and unloading cost at cooperatives stores. Regions with sufficient carry-over stock enjoy price advantages if world prices in the following year go up; however, they need to pay a higher price if the international price goes down. In 2012, two regions enjoyed a lower price due to the coincidence of a higher international price and large carry-over stocks. In Oromia, for instance, the prices of DAP and urea were lowered by $24.40 and $31.50/mt, respectively. For the 2012 cropping season, the average price of DAP per metric ton to the farmers was about $814 in Amhara, $864 in Tigray, $828 in Oromia, and $876 in SNNPR. For urea, farmers paid $648 in Amhara, $641 in Oromia, $712 in Tigray, and about $700 in SNNPR (Table 3.1). Farmers paid these prices only if they had purchased fertilizer at the start of the season and paid in cash. Those who purchased fertilizer on credit had to pay bank interest, which is recouped at harvest time, when farmers sell their produce to cooperatives.

A general point from this exercise is that despite the long chain, fertilizer prices in Ethiopia appear to be very competitive. The price differential (second row from the bottom in Table 3.1) between landed costs and farmgate price is small, and transportation costs account for a large part of the difference. For instance, consider DAP, for which the difference between farmgate price and landed costs at Djibouti is $138 for Tigray, $113 for Amhara, $110 for Oromia, and $127 for SNNPR. As Table 3.1 shows, depending on the region, transport costs alone account for 64–80 percent of these price differentials. Consider DAP in Oromia, where transport and banking fees add up to $91, or about 83 percent of the price difference of $110. The remainder, $27, or about 3 percent of the farmgate price, goes to cooperatives as administrative costs, loading, unloading, and margins. This is surprisingly low, given that this includes all handling costs and associated risks. We further examine this in the next section.

4. COSTS AND SUSTAINABILITY

Retail Prices and Implicit Costs

Even though reductions in transportation costs can be explained by the improvement in infrastructure, the estimates in Table 3.1 in the previous section suggest that the margin in the Ethiopian fertilizer value chain is extraordinarily low. To further probe the issue, we conduct two sets of analyses: a comparison of the average prices in the neighboring countries, and an analysis of the costs involved in maintaining low margins and retail prices. Retail prices of two major types of fertilizers, DAP and urea, in Ethiopia and its four neighboring countries are summarized in Table 4.1. The numbers show that the average retail prices in Ethiopia are 10–30 percent lower than the average national retail prices in the neighboring countries. Average DAP and urea prices in Ethiopia are about 15 percent lower than in Kenya, more than 30 percent lower than the price of urea in Malawi, about 11–12 percent lower than in Rwanda, and 23 percent and 29 percent lower (for DAP and urea, respectively) than in Tanzania.

Table 4.1 Comparison of fertilizer prices, April 2012

Country	DAP	Urea	Ethiopia as % of its neighbors (without adjustments)		Ethiopia as % of its neighbors (with adjustments)*	
			DAP	Urea	DAP	Urea
Ethiopia	885	689	—	—		
Kenya	1,038	845	85	82	92	88
Malawi	—	1,060	—	65	—	70
Rwanda	1,009	790	88	87	95	94
Tanzania	1146	998	77	69	84	75

Source: Constructed using retail prices from the International Fertilizer Development Corporation (IFPDC) database.
Notes: DAP = diammonium phosphate**.** *Adjustments include interest rate subsidy, storage, spoilage, and coop margins. The adjustment amounts to $74/metric ton for DAP and $55/metric ton for urea.

Why are fertilizer prices in Ethiopia 15 percent lower than in Kenya, especially since Kenya has a subsidy program and is better integrated with the rest of the world? As stated earlier, implementation of current fertilizer promotion policies involves implicit costs. For instance, bank interest on fertilizer is fixed at 4.01 percent, which is 8 percentage points lower than the national lending rate of 12 percent. Also, notice in Table 3.1 that there is no allowance for storage costs and spoilage, and the margins for cooperatives are set at a rate lower than the market rates. In the last two columns of Table 4.1, we present Ethiopian prices as a percentage of its neighbors' prices with these adjustments.[11]

Here is an illustration of each of the cost components for DAP:

- If the interest rate was the same as the lending rate of 12 percent, instead of 4 percent, an additional interest charge of $24/mt would be added.
- If the cooperatives were allowed a margin equal to the national lending rate (12 percent) instead of only $6.90 ($1.70 of profit margins and $5.20 of administrative costs), the

[11] Another argument for lower price in Ethiopia is that the transactions costs from the primary cooperatives to farmgate can be very high. Using a unique survey in one of the remotest areas in Ethiopia, Minten et al. (2013a) have estimated that farmers who live about 10 kilometers from the primary cooperatives incur transaction costs that are as high as the costs of bringing fertilizer from Djibouti port to primary cooperatives' center (about 1,000 kilometers). This means, according the estimates in Table 3.1, costs of transporting a ton of fertilizer from the primary cooperative to the farmgate in Ethiopia can be as high as $150 in remote areas! In our view, this extremely high estimate resulted either because the study site was too remote or an overestimation of the implicit costs, such as the opportunity costs of labor and donkeys used in procuring fertilizer.

cooperative unions and primary cooperatives would have to charge an additional $32 per ton, assuming that the stock was held for four months.

- If 1 percent spoilage was allowed, as we found in our survey, $9 per ton would be added.
- If storage costs were allowed, $9 per metric ton would be added.

In other words, if all these costs are added up, retail price of DAP in Ethiopia would have been $959. By making similar adjustments, the price of urea would have been $767. That is, even after making these adjustments, fertilizer prices in Ethiopia remain lower relative to its neighbors, although they come much closer. For instance, the price of DAP in Ethiopia would now be 92 percent of the Kenyan price, instead of 85 percent.

Next we estimate the total implicit costs of fertilizer promotion in Ethiopia by factoring in all cost components. Four of the implicit cost components are the same as before, but instead of per ton, we have calculated total costs. Note that actual cost calculation should consider both consumption and stocks, but since carry-over stocks have become a chronic problem, we discuss this separately in the next section. Also, the implicit cost estimates are generated only because AISE was granted monopoly in 2008. The results are presented in Table 4.2, which shows that total annual cost of promoting fertilizer in Ethiopia has averaged from $29 million in 2010 to $54 million per year since 2012. Since its share is larger and prices are higher, costs associated with DAP have been significantly higher than any other cost elements in our calculation. A simple calculation from Table 4.2 indicates that, excluding storage, DAP has accounted for more than 50–70 percent of the total costs. In contrast, the share for urea in total costs ranged from 12 percent in 2009 to 29 percent in 2012. The annual storage cost, which is the same for DAP and urea, has averaged $5.5 million.

Table 4.2 Estimated Implicit costs of current fertilizer policies, 2008–2012

Sources of Implicit Costs	YEAR				
	2008	2009	2010	2011	2012
Low interest rates (8% less than lending rate)	(in $ millions)				
DAP	9.39	9.87	5.95	9.35	12.31
Urea	3.75	1.53	3.08	4.13	5.80
Subtotal	13.14	11.40	9.03	13.48	18.11
Spoilage & weight loss (1%)					
DAP	2.35	2.47	1.49	2.34	3.08
Urea	1.32	0.53	0.85	1.34	1.79
Subtotal	3.67	3.00	2.34	3.68	4.87
Coop opportunity costs (for six months)*					
DAP	12.91	13.57	8.18	12.86	16.93
Urea	5.15	2.10	4.23	5.68	7.97
Subtotal	18.06	15.67	12.41	18.54	24.90
Storage costs (for six months)**					
(DAP + urea)	4.42	5.61	5.54	5.51	6.33
Grand total	**39.29**	**35.67**	**29.32**	**41.20**	**54.21**

Source: Author's calculation based on AISE data.

Notes: DAP = diammonium phosphate. *Coops receive $6.90, which represents roughly 1% gross return. Therefore, since lending rate is 12%, implicit costs to the coop chain are assumed to be 11 percent. **Storage cost is estimated at ETB 26 (≈$1.55 per ton per month).

Another major element of the costs of fertilizer promotion in Ethiopia is the costs associated with the carry-over stocks. This has become a subject of much debate in recent years. Some argue that carry-over stocks proved beneficial to the country because prices of both fertilizer and cereals increased in the following year. The debate began with a World Bank report published in 2010, which argued that the carry-over stocks in 2008/09 were profitable, as prices shot up in the following year and farmers purchased more fertilizer due to the favorable weather conditions. However, the estimate was for a year when the world price shot up. It follows from the intertemporal arbitrage theory that if stocks are managed properly, the net gains from holding stocks should not be significantly different from zero in the long run. We test this by calculating the costs and benefits of carry-over stocks for a longer time horizon, covering 2002 through 2011 (Table 4.3). As before, there are four main costs components: (1) interest costs (opportunity costs of money tied in stocks), (2) spoilage and weight loss, (3) primary cooperatives' costs, and (4) an adjustment for storage. The potential benefit (loss) from price changes is calculated by multiplying the volume of carry-over stock in year *t* by the magnitude of price rise (decrease) in year *t + 1*. For instance, since price per metric ton in 2003 was $1 lower than the 2002 price, holding a stock of 130,700 tons in 2002 led to a loss of $130,700.

Table 4.3 Benefit–cost analysis of carry-over stocks of DAP, 2002–2011

Types	Year	Quantity ('000 mt)	Retail price ($/mt)	Admini-strative costs	Interest, market rates (12%)	Potential physical losses (2%)	Direct total costs of carry-over	Gain (loss) due to price change	Net benefit (costs) of carry-over
				A	*B*	*C*	*D=(A+B+C)*	*E*	*F=(E–D)*
						(in $ millions)			
DAP	2002	130.7	295	0.92	4.63	0.77	6.32	(0.15)	(6.47)
	2003	2.4	294	0.02	0.08	0.01	0.12	0.14	0.02
	2004	25.1	355	0.18	1.07	0.18	1.43	2.07	0.64
	2006	54.1	438	0.38	2.84	0.47	3.70	1.47	(2.23)
	2007	19.1	465	0.14	1.06	0.18	1.38	7.51	6.13
	2008	37.0	859	0.24	3.82	0.64	4.70	(9.57)	(14.27)
	2009	203.7	600	1.07	14.68	2.45	18.19	(34.90)	(53.09)
	2010	148.2	429	0.63	7.63	1.27	9.53	36.00	26.47
	2011	135.0	672	0.49	10.89	1.81	13.19	(24.62)	(37.81)
Average		**83.9**	**490**	**0.45**	**5.19**	**0.86**	**6.51**	**(2.45)**	**(8.96)**
UREA	2002	94.6	229	0.67	2.60	0.43	3.70	0.42	(3.28)
	2003	4.6	233	0.04	0.13	0.02	0.19	0.37	0.18
	2004	32.6	314	0.23	1.23	0.20	1.67	2.18	0.52
	2006	91.2	381	0.64	4.17	0.70	5.51	4.02	(1.49)
	2007	26.1	425	0.19	1.33	0.22	1.74	4.76	3.02
	2008	45.8	608	0.30	3.34	0.56	4.19	(8.00)	(12.20)
	2009	97.8	433	0.52	5.08	0.85	6.44	(4.37)	(10.81)
	2010	104.0	388	0.44	4.85	0.81	6.10	13.58	7.48
	2011	132.5	519	0.48	8.24	1.37	10.10	(16.74)	(26.84)
Average		**69.9**	**392**	**0.39**	**3.44**	**0.57**	**4.40**	**(0.42)**	**(4.82)**

Source: Authors' calculations based on AISE data on stocks, prices, and admin costs; loss estimates (caking and moisture loss) are based on IFPRI (2012) rapid appraisal survey; lending rates are from the National Bank of Ethiopia.

Notes: mt = metric tons; DAP = diammonium phosphate.

Our results, reported in Table 4.3, suggest that the annual costs of carry-over stocks for DAP and urea have averaged $8.96 million and $4.82 million, respectively. In addition, price fluctuation resulted in losses of $2.45 million for DAP and $0.42 million for urea. Therefore, annual average costs of holding carry-over stocks for both types of fertilizer amount to $13.78 million. Given, carry-over stock averaged 150,000 tons; this implies that the cost of carrying over a ton of fertilizer has averaged $92 if the losses due to price fluctuations are included and $73 if losses due to price fluctuations are excluded. In 2012, the stock reached about half a million tons, but we could not calculate the costs because 2013 weighted price was yet to be determined. However, the outcome is predictable: If prices in 2013 remain the same as in 2012, the government will lose more than $36 million, implying that the government can *break even* only if the 2013 weighted (DAP and urea) price goes up by $73 per ton. To put this differently, any price increase smaller than $73 per ton will result in a loss. These are *deadweight* losses in the sense that they benefit neither the government nor the farmers. These resources could have alternative uses, including supporting educational programs, safety net programs, agricultural research, and other public programs. To put these numbers in perspective, the potential loss of about $36 million in 2012 (assuming no price change) is roughly 10 percent of the cost of the country's well-known Productive Safety Net Programme, which supports about eight million beneficiaries.

What implications do these costs have for fertilizer promotion policies in Ethiopia? First, these are subsidies in an economic sense and will be recorded somewhere in the government's ledger—though not as subsidies. Lower interests, no spoilage allowance and storage costs, and very low margins for the primary cooperatives imply that government will have to pay for these costs at some point in time. Second, relative to total fertilizer use in the country, these costs are small as a percentage of retail prices. For instance, in 2012, total fertilizer use was about 650,000 tons and total policy cost, including cost of carry-over, was about $68 million, equivalent to $105 per ton. On the other hand, the weighted average value of 650,000 tons of DAP and urea comes to about $716 million, which implies that the costs are about 14 percent of the fertilizer valued at primary cooperative prices. This is indeed small and, if eliminated, it is unlikely to significantly reduce the domestic demand. For simplicity, assuming a price elasticity of demand of –0.5, one can conclude that, *ceteris paribus,* elimination of these implicit supports would have resulted in a 6.5 percent (42,000 tons) decline in fertilizer use. Thus, one can broadly argue that only a fraction of recent growth is explained by these implicit supports.

However, this leads to a much broader question. If the support was so minimal, what explains the more than 60 percent increase in fertilizer use (from about 400,000 tons in 2007 to 650,000 tons in 2012) since 2008? Our cost estimates can be low, as we may not have captured all the costs. However, even if our estimates were three times larger, we could still explain only about 20 percent of the increase under an elasticity estimate of –0.5, which we think is reasonable. Therefore, it is clear that the implicit support alone cannot explain the increased use of fertilizer since 2008; hence, other drivers of recent growth in fertilizer use must exist. One of such drivers is the improvement in crop prices relative to fertilizer prices since 2007. As Rashid and Lemma (2011) have discussed, following a restriction on foreign exchange, domestic prices of all major cereals went far above the import parity in 2008. In fact, domestic prices of wheat and maize remained above import parity for more than two years, starting in May 2008, and reached as high as more than $300 per ton for a few months in 2008 and 2009. This price increase together with favorable weather conditions provided added incentives for the farmers to purchase chemical fertilizer and boost demand. When domestic prices declined, so did the demand, which apparently government did not account for in importing fertilizer leading to overestimation of demand. Another factor, as pointed out in the World Bank (2011) report, the government took some active actions to improve the logistics by mobilizing trucks, even using military trucks at one point in time.

To sum up, analysis of available secondary data shows that prices of fertilizer in Ethiopia are significantly lower than in the neighboring countries. However, if all implicit costs are accounted for, Ethiopian prices come closer to those of Kenya and Rwanda but remain much lower than those of Tanzania and Malawi. Annual estimated cost of executing fertilizer promotion policies, since the country embarked on the new set of policies, has averaged about $40 million, with the highest estimate reaching more than $54 million in 2011. In addition, the annual cost of holding carry-over stocks has averaged about $14 million, with the highest estimate reaching as much as $64.70 million in 2012 (Table 4.3). Thus, we conclude that, although Ethiopia does not have a direct subsidy program, fertilizer promotion policies have not been inexpensive.

Sustainability

The sustainability of the current policy regime depends heavily on the sustainability of the primary cooperatives, which are small organizations with limited managerial and accounting skills.[12] Therefore, making them sustainable business entities is a difficult task. As shown in the Table 3.1, a primary cooperative is entitled to charge $1.70 per ton as a profit margin and $5.20 per ton as administrative costs, which means that a primary cooperative dealing in 100 tons of fertilizer will get total revenue of $690, or about ETB 12,000. The salary of security staff (generally two people are needed) can consume this entire revenue. Additionally, theft, caking, or weight loss due to a management problem can add up to half a ton of fertilizer. A primary cooperative would have to close for the lack of operating funds under such circumstances. Although cooperatives have different sources of income, the assumption is that they are not established for profit but rather to provide services for their members. Hence their profit margin is minimal. Another way to look at these margins is to compare them with the overhead charged by various national organizations for managing a project. It is a general practice to charge about 12 percent overhead on research projects administered by the national research organizations (and much higher for international organizations).

Even though primary cooperatives do not have to invest, they are responsible for safeguarding and distributing fertilizers. For providing all these services, they are offered an overhead of less than 1 percentage point. Based on our opinion survey of the cooperative unions' managers, these margins are low, and they often find it difficult to break even in their input distribution business.[13] A comparison with other countries corroborates the opinion of these cooperative managers. Agro dealers in Kenya and Tanzania make 5–8 percent of the total product cost, which are 6 to 10 times the primary cooperatives' profit margins in Ethiopia. This needs to change for primary cooperatives to serve as a sustainable business model. Additionally, the primary cooperatives have limited managerial skills. Most managers of these cooperatives have only a primary level of education but have the responsibility of doing challenging tasks with limited resources and weak infrastructure.

Some simple analysis can demonstrate how the predetermined margins can jeopardize the primary cooperatives' survival. According to available statistics, there are about 14,000 primary cooperatives in Ethiopia (Minot and Mekonnen 2012). However, not all of these primary cooperatives deal with cereals or fertilizer; some of them are coffee cooperatives or financial cooperatives. Since 575,000 tons of fertilizers are distributed, a typical primary cooperative should be dealing in about 50 mt of fertilizer. However, during our rapid assessment, we observed that many smaller primary cooperatives deal in about 20–30 tons of fertilizer. Therefore, we have considered a range of operations, with a minimum of 35 tons and a maximum of 85 tons.

Since margins are fixed, calculation of revenue is straightforward—it is the product of the size of operation and the margins of $6.90 ($1.70 + $5.20 from Table 3.1). To calculate costs, we have assumed that each primary cooperative needs a year-round security guard at a monthly salary of ETB 400 and a bookkeeper for three months at a monthly salary of ETB 1,100. The net profit calculation based on these parameters suggests that fertilizer trade is unprofitable if a primary cooperative deals in less than 55 tons of fertilizer (Table 4.4). It becomes barely profitable when the scale of operation reaches to 70 tons. If the cost estimates are reasonable, smaller primary cooperatives are clearly losing money from fertilizer distribution. This implies that for the current strategy to be sustainable, either the government will have to write off the losses in the long run or primary cooperatives will have to recuperate through output sale or membership fees. For the government to write off the costs essentially implies subsidizing the

[12] Note that that fertilizer distribution is profitable for the cooperative unions because they operate at a much larger scale.
[13] Also see World Bank (2011).

distribution, and primary cooperatives that fund fertilizer distribution with alternative revenue sources will have no incentive to continue dealing in fertilizer.

Table 4.4 Primary cooperatives' real profit under various scenarios

Scale of primary cooperatives' operation	Amount of fertilizer (mt)	Revenue ($)			Costs ($)			Per ton profit (loss) in $
		Profit allowance ($1.70/mt)	Admin cost allowance ($5.20/mt)	Total Revenue	Security Guard	Book-keeper	Total Costs	
Low	25	42.5	130	173	273	187.5	460	(11.51)
Medium low	40	68	208	276	273	187.5	460	(4.61)
Average	55	93.5	286	380	273	187.5	460	(1.47)
Medium high	70	119	364	483	273	187.5	460	0.33
High	85	144.5	442	587	273	187.5	460	1.49

Source: Authors' calculation based on the IFPRI (2012) rapid appraisal survey.

Notes: mt = metric tons; ETB – Ethiopian Birr.

Assumptions: 1. Warehouse security guard costs ETB 400 per month and is employed for 12 months. 2. Bookkeeper costs ETB 1,100 per month and is employed for three months. 3. Revenue calculations are based on government-determined profit and administrative cost allowance.

A simple pilot program can test the validity of the above assertion. Here is how it can be done. In the main cereal-growing areas, with good market access, the government can select a few locations where private agrodealers are allowed to operate with the same set of profit and administrative cost margins. These dealers will buy fertilizer from the central warehouses or cooperative unions at prices determined by the AISE and the MoA. If the dealers can profitably operate alongside cooperatives, this would imply either (a) that our estimates of the primary cooperatives' costs of operation are wrong or (b) that the private-sector dealers are more efficient than the cooperatives.

There are at least three compelling reasons to carry out this pilot. First, fertilizer is now more than a half-billion-dollar market; and cornering such a market by unscrupulous private traders, as perceived by many, is very limited. Besides, on the argument of economies of scale, the government can continue to have control over the value chain up to the central warehouse and cooperative union level, and the agrodealers will be registered so that it is easier to make them accountable if they engage in dishonest acts such as adulterations. Second, in grain markets (including coffee), which were controlled by the government until the early 1990s, several billion dollars' worth of commodities are now traded by the private sector, and all available studies suggest that the market has become increasingly competitive over the years (Rashid and Negassa 2013; Minten et al. 2013b). Like grain, fertilizer is a private good, although it requires close regulation to avoid moral hazard problems (for example, adulteration). Finally, in principle, the proposed pilot is similar to Productive Safety Net Programme in that cash transfer is done in the areas with well-functioning markets. In regions (or subregions) with good market access, allowing private dealership can be a win–win proposition, as the scarce public resources can be spent in the areas with limited market access.

5. YIELD RESPONSE AND PROFITABILITY

An understanding of the effective demand is essential in executing any fertilizer promotion policies. This is particularly true for Ethiopia, given the country's consistent mismatch between policy target and effective demand of fertilizer, which in the absence of market failures depends on the profitability of fertilizer use. However, it is hard to deny the presence of market failures—such as inadequate provision of public goods (for example, roads) and the absence of risk management (credit and insurance) institutions. Since only a small proportion of farmers use fertilizer and at a very low rate, fertilizer use can potentially increase under appropriate policy environment. The key policy challenge is knowing whether the effective demand is hindered by market failures (for example, liquidity constraints and lack of information on the returns to fertilizer) or the fact that the profitability of fertilizer use is just too low to justify its use. If it is the former, fertilizer subsidies may be justified, but if the latter, more effort is needed to increase yield response and reduce fertilizer costs.

In this section, we present some yield response and profitability of fertilizer. A commonly used measure of profitability is the value-cost ratio (VCR), which we use for estimates from the experimental plots, as well as estimates of yield response elasticity using the 2008 IFPRI-EDRI survey. This ratio is the value of additional production due to fertilizer application to the total cost of fertilizer applied. These estimates are generally calculated on the basis of experiments, where two identical plots are cultivated with the same crop (say maize), but only one plot is treated with fertilizer. After harvesting, the difference in the value of additional outputs due to fertilizer use is divided by the cost of the fertilizer applied to the plot. Suppose that total output from the plot that received fertilizer is X, and the output from the plot that did not receive fertilizer is (X – α), where $\alpha \geq 0$. If the price of fertilizer is P^f, the price of maize is P, and Q^f amount of fertilizer is applied, then the VCR is given by the following:

$$VCR = \frac{PX - (X - \alpha)P}{P^f Q^f} = \frac{P\alpha}{P^f Q^f} \tag{1}$$

This equation implies that fertilizer would be profitable if the VCR is greater than 1. However, it is commonly argued that a VCR of at least 2 is needed for fertilizer to be profitable in Africa. In other words, the value of additional production due to fertilizer use must be twice as much as the cost of the fertilizer. A high estimate is recommended to account for many factors that can influence fertilizer profitability. For example, household-specific characteristics—such as geographic location, credit availability, access to markets, and entrepreneurial skills—greatly influence profitability but are not important in experimental stations. Besides, many risk factors that are important for typical farmers (such as infestation and weather risks) can generally be controlled in experimental stations but not at the household level. In countries where those risks are minimized, fertilizer can be profitable at VCRs much lower than 2. For example, estimated VCRs at farmers' fields were less than 2 in many Green Revolution countries in Asia (Desai 1982; Stone 1989); yet farmers adopted seed-fertilizer technology because two major sources of risks, weather risk and price risk, were eliminated with irrigation and price stabilization schemes.

Several sets of VCR estimates are available in Ethiopia, and almost all of them are based on the plot-level data from the experimental stations. Demeke et al. (1998) presented the first set of such estimates since the government eliminated subsidies in the 1990s. They reported that although VCRs were greater than 2 in 1992, they fell far below 2 after the withdrawal of subsidies in 1997. Spielman, Alemu, and Kelemwork (2013) have reestimated the VCRs for teff and maize for 2004 and 2008, and according to their estimates VCRs are 2.12 and 1.91 for maize and teff, respectively. In 2010, the World Bank commissioned a larger study to assess the fertilizer profitability in the country. This study reported that VCR of fertilizer in Ethiopia is at least 1.7 for all cereals in all four cereal-growing regions. However, the variation across crops and regions is high; estimates range from 1.7 to 4.2 for teff, 2.0 to 6.5 for wheat, and 1.7 to 5.3 for maize (Table 5.1).

Table 5.1 Estimated value–cost ratios for 2009–2010 crop year in cereal-growing regions

Crop / Region	Crops			Fertilizer			
	Incremental yield (in quintal/ha)	Crop price (ETB/ quintal)	Value of extra output (ETB/ quintal)	Application rate quintal /ha	Fertilizer price (ETB/ quintal)	Cost (ETB/ha)	VCR
1. Teff							
1.1 Tigray	2.2	1,000.7	2,201.5	1.9	692.2	1,323.5	1.7
1.2 Amhara	3.4	699.8	2,379.3	1.7	820.3	1,433.1	1.7
1.3 Oromia	3.9	709.7	2,767.8	1.2	744.4	685.0	4.0
1.4 SNNP	3.1	712.4	2,208.4	1.1	773.2	835.1	2.6
2. Wheat							
2.1 Tigray	8.2	669.5	5,489.9	1.8	692.2	1,248.0	4.4
2.2 Amhara	5.8	449.9	2,609.4	1.6	820.3	1,312.5	2.0
2.3 Oromia	12.4	442.9	5,490.7	1.1	744.4	848.6	6.5
2.4 SNNP	7.3	445.9	3,255.1	1.4	773.2	1,050.8	3.1
3. Maize							
3.1 Tigray	4.1	523.4	2,145.9	1.8	692.2	1,246.0	1.7
3.2 Amhara	12.1	357.3	4,323.3	2.4	820.3	1,996.6	2.2
3.3 Oromia	10.2	337.5	3,442.5	1	744.4	749.6	4.6
3.4 SNNP	6.4	401.3	2,568.3	0.6	773.2	486.3	5.3

Source: World Bank (2010b) based on data from several sources including regional agricultural research organizations of the Ethiopian Institute of Agricultural Research.

Note: ha = hectare; ETB = Ethiopian Birr; VCR = value-cost ratio; SNNPR =Southern Nations, Nationalities, and Peoples' Region.

Since most of the above VCRs are calculated based on data from experimental plots, they do not account for household-specific behavioral, institutional, and agroclimatic conditions. As a result, these estimates are generally considered to represent the higher bounds. While they have their own pitfalls, estimates from well-designed household surveys can better represent the realities of the farming households. We attempt this using EDRI-IFPRI household survey data. Two estimates—yield response and price elasticity of demand—are of particular interest from a policy standpoint. Yield response is estimated using a reduced-form quadratic production function. Estimating price elasticity of demand for fertilizer is complex because household surveys generally have both users and nonusers of fertilizer. It becomes particularly problematic if the proportion of nonusers is large, as in Ethiopia, where data take on the properties of nonlinear cornering solutions (Ricker-Gilbert, Jayne, and Chirwa 2011). The traditional approach to deal with such situation has been the Tobit model, but the model is too restrictive; it assumes that the same underlying process determines both the decisions to use fertilizer and the quantity of fertilizer to be used. The double-hurdle model, proposed in Cragg (1971), overcomes this restrictive assumption. Formally, suppose that the unconditional expected value of fertilizer use (y) is expressed as the probability that a household uses fertilizer multiplied by the expected value of fertilizer use given that the household uses it. Formally, this is expressed as

$$E(y) = \text{Prob}(y>0)\, E(y \mid y>0)$$

$$= \Phi\,(x_2\beta_2+\sigma\lambda) \quad (2)$$

where $\Phi = \Phi(X_1\beta_1/\sigma)$, $\lambda = \phi/\Phi$, and the subscripts 1 and 2 refer to the first or second stage of the double-hurdle model. The partial effect of the price of fertilizer (x_i) on the unconditional expected value of y can be written as follows:

$$\frac{\partial E(y)}{\partial x_i} = \text{Prob}(y>0)\frac{\partial E(y|y>0)}{\partial x_i} + \frac{\partial \text{Prob}(y>0)}{\partial x_i}E(y|y>0) \quad (3)$$

McDonald and Moffit (1980) showed that this can be expressed in terms of the parameters as follows:

$$\frac{\partial E(y)}{\partial x_i} = \Phi\beta_{2i}[1-\lambda(z_2+\lambda)] + (z_2+\lambda)\phi\beta_{1i}, \quad (4)$$

where

$zi = Xi\beta i/\sigma$ and $\phi = \phi\,(X1\beta 1/\sigma)$.

The first term on the right side can be interpreted as the partial effect of fertilizer price (x_i) on the fertilizer use among users $E(y \mid y>0)$, while the second term describes the partial effect of price on the probability that a household uses fertilizer. The elasticity of fertilizer use with respect to price is calculated from this equation.

Results of this exercise are presented in Table 5.2. The estimated VCRs are higher than 2.0 only for maize in all four regions. The estimates range from 1.4 to 2.17 teff, 1.27 to 2.34 for wheat, and 2.34 to 2.03 for maize. Clearly, these VCR estimates are far lower than the estimates based on the data from the experimental plots. No estimates are more than 2.5, but at the same time, no estimates are lower than 1.0. The lowest VCR estimate we have is 1.27. This implies that in the absence of weather and price risks, fertilizer profitability will be 27 percent within a period of six months, equivalent to an annual rate of 54 percent, and more than four times the national average lending rates at commercial banks. Furthermore, fertilizer to commodity price ratio, a key determinant of profitability, remains low in Africa. Furthermore, in many East and Southern African countries, domestic prices are distorted due to public intervention, which also can affect the VCR (Jayne et al. 2003). In 2008, fertilizer demand suddenly picked up in Ethiopia, when domestic cereal prices skyrocketed and went far above import parity for a prolonged period, significantly improving the VCR and fertilizer demand (World Bank 2009).[14] This would be different with various crops (teff, wheat, and maize), given the agroecological suitability and infrastructural development. Thus, we conclude that fertilizer is profitable in Ethiopia and the low adoption is the result of other factors, such as high-risk premiums and institutional bottlenecks.

[14] For further details on the reason domestic prices exceed import parity, see Rashid and Dorosh (2009) and Rashid and Lemma (2011).

Table 5.2 Estimated yield response elasticity, demand elasticity, and value–cost ratios

Region/ Crop	Yield response		Value cost ratios		Price elasticity of demand
	All HH	Fertilizer users	All HH	Fertilizer users	Entire sample
Tigray					
Teff	0.06	0.21	2.17	2.54	–0.16
Wheat	0.06	0.17	2.34	2.52	–0.21
Maize	0.02	0.23	2.26	2.70	–0.12
Amhara					
Teff	0.16	0.20	1.68	1.86	–0.05
Wheat	0.11	0.20	1.47	1.66	–0.09
Maize	0.18	0.25	2.03	2.34	–0.02
Oromia					
Teff	0.15	0.26	1.65	1.83	–0.10
Wheat	0.12	0.19	1.35	1.47	–0.12
Maize	0.04	0.17	2.14	2.39	–0.07
SNNP					
Teff	0.14	0.23	1.40	1.60	–0.09
Wheat	0.21	0.30	1.27	1.38	–0.09
Maize	0.09	0.41	2.34	2.96	–0.04

Source: Authors' calculations based on EDRI-IFPRI household survey 2008.
Notes: HH = households; SNNPR = Southern Nations, Nationalities, and Peoples' Region.

The estimated price elasticity of demand for fertilizer is small, with the absolute values ranging from 0.21 for wheat in Tigray to as low as 0.02 for maize in Amhara. Clearly, these estimates will not be very encouraging for the policy practitioners because low price elasticity suggests that the price subsidy will not have that big of an effect. However, given our sample, these estimates need to be interpreted cautiously. In 2008, the survey year, the price of fertilizer was predetermined and little variation was observed across households. Furthermore, as the estimates in Table 3.1 suggest, there is very little price difference across regions. The transportation costs, the biggest cost component in the value chain, vary from \$51 to \$63 from the Djibouti port to central warehouses, and \$34 to \$19 from central warehouses to the primary cooperatives, depending on the region. Therefore, it is not surprising that the price responsiveness of fertilizer is low, when estimated from the household survey.

In the context of yield response and profitability, a bigger question is whether or not the right kind of fertilizer is applied to the soil, which varies widely across agroecological zones. This variation in the soil types essentially implies that different kinds of nutrients have been applied to maintain the soil fertility and perhaps increase the yield response and profitability. Some recent studies argue that severe organic matter depletion has potentially reduced Ethiopian agricultural gross domestic product by as much as 7 percent (Zeleke et al. 2010). To address this problem, the government has now embarked on setting up fertilizer-blending facilities in the country. This will have both short- and long-term impacts if it is successful. For example, in the short term, blended fertilizer is likely to increase the yield response and profitability. On the other hand, use of the right mix of fertilizer will improve soil quality by slowing down degradation or even improving the soil health. Rigorous empirical analysis has not yet been done, but early assessments indicate that this has potential to lower the fertilizer costs.[15]

[15] For details, visit http://www.ata.gov.et/programs/system-programs/soil/.

6. SUMMARY AND IMPLICATIONS

Use of chemical fertilizer in Ethiopia has grown remarkably since the official elimination of subsidies in the 1990s. This growth has occurred under various policy regimes, but it accelerated under a new set of policies adopted in 2008. Two key components of this policy reform are (1) granting monopoly control over fertilizer imports to the Agricultural Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization. This paper has presented an assessment of the challenges and opportunities of these sets of new policies. In particular, it has analyzed the value chain, costs and sustainability of current policies, profitability of fertilizer use, as well as potential for growth.

The results indicate that the fertilizer value chain in Ethiopia is competitive relative to its neighbors. When retail prices of fertilizers in US dollars are compared, the prices of DAP and urea in Ethiopia are 12–35 percent lower than in four of its neighboring countries (Kenya, Uganda, Rwanda, and Tanzania). The price difference shrinks if all implicit government supports in Ethiopia are factored in, but still remain significantly lower (8–25 percent). Reductions in transactions costs due to heavy investments in infrastructure can explain part of these differences, but it is also possible that some costs elements are not captured by our survey. While the adjustments of all implicit support cannot explain the price differences with its neighbors, these supports add up to significant fiscal costs—estimated to have averaged $40 million per year since 2008. The estimates become much higher if the costs of carry-over stocks are added, which is estimated to be $14 million per year during 2002–2011. It is important to note that the clearly increasing trend since the country embarked on a new policy in 2008; and if only the 2008–2011 period is considered, the annual average costs of carry-over stocks goes up to $30 million. If the implicit supports and the costs of carry-over stocks are added, the cost of fertilizer promotion policies averaged about $105 million, equivalent to about 15 percent of the retail price. Thus, we can conclude that although Ethiopia does not have a direct subsidy program, fertilizer promotion policies have not been inexpensive.

One major challenge we highlight in the current fertilizer value chain is the costs and margins allowance for the primary cooperatives. This study finds that fertilizer trade is unprofitable for primary cooperatives if they deal in less than 55 tons, and it becomes barely profitable when the trade volume reaches 70 tons. This implies that if the current strategy continues, either the government will have to write off the losses that the cooperatives incur, or primary cooperatives will have to recuperate losses through output sale or membership fees. For the government to write off the costs essentially implies subsidizing the distribution. On the other hand, if primary cooperatives have to fund fertilizer distribution with alternative revenue sources, they will have no incentive to continue dealing in fertilizer. This paper has argued that one option to sustainably address this challenge would be to gradually allow private dealers to enter markets. Under this option, AISE continues to take advantage of the bulk purchase, and the agro dealers purchase from the central warehouse or cooperative union at AISE-determined weighted-average prices. Since AISE will be controlling the value chain up to the central warehouse, the likelihood of the private sector monopolizing fertilizer markets will be minimal. Furthermore, since the dealers will be registered, it will be easier to deal with the moral hazards (for example, adulteration). As a cautious move, this can be launched on a pilot basis.

The analysis of profitability suggests that fertilizer in Ethiopia is profitable at both experimental plots and at the farmers' fields. All estimates of VCR at the experimental plots are higher than 2.0; but when econometrically estimated using household survey data, the VCR estimates become lower. The estimates remain greater than 2.0 only for maize in all regions and between 1.27 and 1.86 for wheat and teff. If one goes by the conventional wisdom that VCR needs to be greater than 2.0 in developing countries, fertilizer in Ethiopia would not be profitable for wheat and teff in Amhara and SNNPR. However, note that the lowest estimated VCR of 1.27 implies that the return to fertilizer use is 27 percent, and since the cropping cycle is no longer than six months, this translates a 54 percent annual return—more than four times the national lending rates. Furthermore, in some examples from Asia, early estimates of VCR were smaller than 2.0; yet the Green Revolution took root in those countries. Therefore, this paper argues that the fertilizer market is profitable in Ethiopia and that the low adoption rate can be due to other factors involving risks and supply chain bottlenecks.

Regarding future potential, this paper highlights two areas of growth. The first area is increasing fertilizer use in other cereals. Currently, about 2.6 million ha, 35 percent of total cultivated land, are allocated to cereals (barley, rice, millet, and so forth), but only about 4 percent of this area is fertilized. Even less fertilizer is used in the high-potential regions of Amhara and Oromia, where 1.9 million ha of cultivated land is allocated to these crops. These crops have received little attention until recently. The government has been able to attract two large brewing companies from Europe, Heineken and Diageo, to set up brewing plants in Ethiopia. This public–private partnership is likely to boost fertilizer use in barley. There are also initiatives to promote rice, for which irrigated land is expected to triple from 26,000 ha to 78,000 ha by 2014, and increase even more to 775,000 ha by 2019. The other initiative that is likely to increase fertilizer use is the establishment of blending facilities. If successful, this will not only lower costs and increase the returns to fertilizer use but also directly contribute toward soil fertility management.

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