4 Seed, Fertilizer, and Agricultural Extension in Ethiopia

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Over the past two decades, decisionmakers in Ethiopia have pursued a range of policies and investments to boost agricultural production and productivity, particularly with respect to the food staple crops that are critical to reducing poverty in the country. A central aim of this process has been to increase the availability of improved seed, chemical fertilizers, and extension services for small-scale, resource-poor farmers, particularly those cultivating food staple crops. Although there is some evidence to suggest that the process has led to improvements in both output and yields during this period, decisionmakers still recognize that there is extensive room for improvement. And given the persistent food security issues facing Ethiopia year to year, there is a sense of urgency underlying the need for improvement.

This chapter begins with a brief overview of efforts to promote improved seed, chemical fertilizers, and extension services in Ethiopia. Following a brief review of sequential programs aiming to promote agricultural development and intensification, we focus this discussion of history to three policy "episodes" that have occurred over the past two decades.

We then examine the systems and markets for seed, fertilizer, and extension. We do so by exploring both the theoretical and practical roles of the public and private sectors as they relate to seed, fertilizer, extension systems, and markets. We conclude by offering several policy suggestions that aim to encourage investment, improve incentives, and strengthen the institutions necessary to improve smallholder access to improved seed, chemical fertilizers, and extension services in Ethiopia.

Note that this chapter abstracts from the wider political economy issues relating to the governance of systems and markets for agricultural inputs. These are acutely important issues in Ethiopia's growth and development trajectory. However, elucidation of Ethiopia's complex political economy demands separate and distinct treatment to address the topic in an insightful and constructive manner.[1]

1. Examples include studies by Aalen (2002); Pausewang, Tronvoll, and Aalen (2003); Vaughan and Tronvoll (2003); Gebre-Egziabher and Berhanu (2007); and Segers et al. (2008) on

Ethiopia's Input Systems and Markets in Historical Perspective

Ethiopia presents one of the most important global challenges in agricultural development. It is among the poorest countries in the world, and its agricultural sector accounts for about 47 percent of national gross domestic product (GDP) and three-fourths of employment; 90 percent of the poor reside in rural areas. Rural poverty is further compounded by extreme land shortages in the highlands (where per capita land area fell from 0.5 hectare in the 1960s to only 0.2 hectare by 2008), low food productivity (with cereal yields averaging around 1.5 tons per hectare), recurrent droughts and variable rainfall, and, as a consequence, high variability in agricultural production (World Bank 2005).

Accordingly, the Government of Ethiopia (GoE) has consistently emphasized agricultural productivity growth and food security in its long-term development strategies. Key components of these strategies date back to the 1950s and the introduction of policies and programs specifically aimed at increasing access to modern inputs and extension services for the country's largely smallholder-based agricultural sector (Table 4.1).

The first such programs were organized as comprehensive integrated package projects (CIPPs) and promoted by the imperial regime during the period 1968–73. On-the-ground implementation focused on the promotion of modern inputs, credit, and extension services and the formation of cooperative societies, and these were highlighted by area development programs—the Chilalo Agricultural Development Unit (1967), the Wolaita Agricultural Development Unit (1970), and the Ada'a District Development Project (1972). Although these programs helped to develop Ethiopia's expertise in agricultural intensification, their scale was too small to boost output or productivity. Thus, by the end of the imperial era Ethiopia's extension services reached only about 16 percent of the farming population, while input and credit provision catered largely to the feudal class rather than the smallholder population engaged in food production (Rahmato 2004).

The first Minimum Package Program (1971–79) attempted to expand access to modern inputs such as improved seed and fertilizer while simultaneously reducing the level and cost of services provided to smallholders. A minimum package area comprised about 10,000 farm households residing along a main all-weather road for 50–75 kilometers and away from the road for 5–10 kilometers on both sides.

Although the program was designed during the imperial era, its implementation continued into the military Derg regime that followed (1974–91). During this latter regime, economic reforms led to significant changes in Ethiopia's rural landscape. The feudal system was summarily dismantled; agricultural pro-

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administrative decentralization and the concentration of political power in Ethiopia; Dom and Mussa (2006a, 2006b) on the influence of decentralization on extension services; Keeley and Scoones (2000) on environmental policymaking; or Spielman, Cohen, and Mogues (2009) on governance and cooperatives in Ethiopia.

TABLE 4.1 Policy regimes and development programs in agricultural input systems and markets, 1957–95

Period	Intervention/event	Focus/objectives	Remarks
1957–67	First and Second Five-Year Development Plans	Develop large-scale commercial farms and coffee exports.	Subsistence farming was neglected.
1968–73	Third Five-Year Development Plan (Comprehensive Integrated Package Projects)	Develop transportation infrastructure; disseminate high-input technologies, credit, and extension; form cooperative societies.	Implementation revolved around three comprehensive extension programs that focused on high-potential areas only.
1971–79	Minimum Package Program I (MPP-I)	Expand geographic coverage of the comprehensive extension programs; provide fertilizer, credit, and extension to "minimum package areas."	Fertilizer procurement was managed by the Agricultural and Industrial Development Bank, distribution by the Ministry of Agriculture (MoA).
1978	Agricultural Marketing Corporation (AMC)	Improve the management of agricultural input importation, storage, and transport by handing over control of these tasks to the AMC.	MoA maintained the role of distributing fertilizer to farmers, disbursing credit, and estimating fertilizer demand through approximately 18,000 peasant associations.

1980–85	Minimum Package Program II (MPP-II)	Expand input supply and extension service coverage three-fold.	Actual provision of inputs and extension was limited due to a lack of financial support for MPP-II, increasing inefficiency in MoA and AMC, fertilizer overstocking due to inaccurate demand estimates, and poor institutional coordination of input deliveries.
1984	Agricultural Input Supply Corporation (AISCO)	Improve the importation and distribution of fertilizer and the marketing of other agricultural inputs.	As a successor to AMC, AISCO was limited by the lengthy bureaucratic process needed to secure foreign exchange, high freight costs, lack of proper port facilities, high inland transport costs, inaccurate demand estimates, and organizational inefficiency.
1986–95	Peasant Agricultural Development Program (PADEP)	Provide inputs, credit, and extension services to smallholders organized into approximately 2,900 farmer service cooperatives using a training and visit extension approach.	As a successor to MPP-II, PADEP aimed to cover eight development zones across the country but received financing sufficient for only three zones, all located in high-potential areas.

SOURCES: Demeke et al. (1998); Stepanek (1999); Gebremedhin, Hoekstra, and Tegegne (2006); Abate (2008); authors.

duction was organized around peasant cooperatives, state-owned farms, and collectives; and the formal research and extension systems were expanded throughout the country. But by the end of the Derg regime, the extension services had been reduced to instruments of political control over the peasantry, while input and credit provision was largely focused on covering the inefficiencies of large state farms and peasant collectives (Wubneh 2007).

Since the end of the Derg regime in 1991, the GoE has introduced new policies to intensify cereal production, accelerate agricultural growth, and achieve food security under a national economic strategy known as Agricultural Development–Led Industrialization (ADLI) (FDRE 1993, 2002, 2006). During the 1990s, ADLI set in motion a series of reforms that sought to generate a more supportive macroeconomic framework, liberalize markets for agricultural products, and promote the intensification of food staple production through the use of modern inputs, especially seed and fertilizer packages (FDRE 2002, 2006). The intensification campaign focused on cereals in the moisture-reliable highlands, where 60 percent of the rural population lives and where the strategy had the best chance of success.

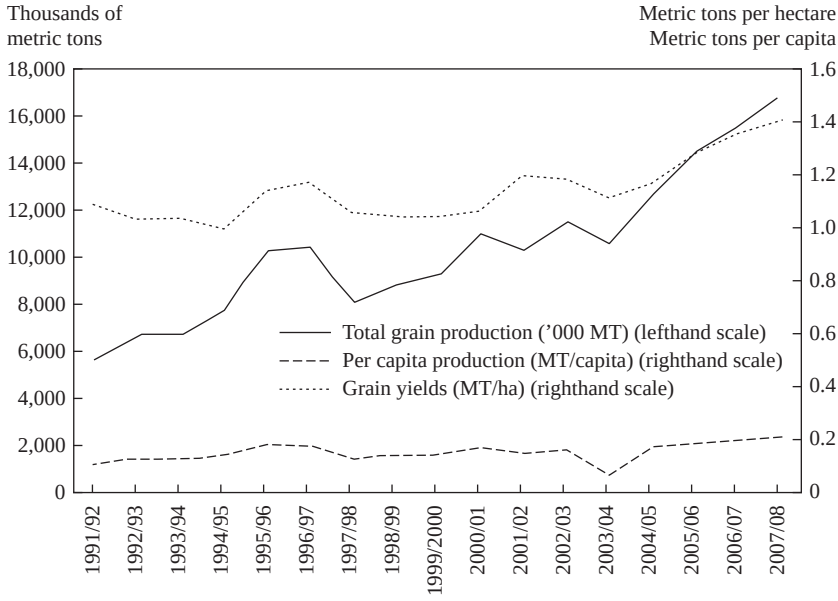
By and large, the GoE's macroeconomic reforms have been successful, resulting in more than a decade of sustained economic growth. Similarly, the GoE's cereal intensification efforts have experienced a somewhat similar degree of success, although growth has been more episodic than continuous, with fairly stagnant per capita production of grain (Figure 4.1).[2]

The first episode of success ran from about 1994/95–2000/01 and hinged on the achievements of the National Agricultural Extension Intervention Program (NAEIP) (Table 4.2). The NAEIP was a scale-up of the Participatory Demonstration and Training Extension System (PADETES), an integrated program of extension, seed, fertilizer, and credit that was piloted by Sasakawa Global 2000 (SG2000), an international nongovernmental organization. The NAEIP reached about 40 percent of the roughly 10 million farm households in Ethiopia over the 10-year period beginning in the mid-1990s. The extensive data from millions of demonstrations carried out through PADETES (3.6 million in 1999 alone) indicated that the adoption of seed-fertilizer technologies could more than double cereal yields (Table 4.3) and would be profitable to farmers in moisture-reliable areas (Howard et al. 2003).

This episode was succeeded by a period of volatility (2001/02–2002/03) that demonstrated just how susceptible Ethiopia's agricultural economy is to weather and price shocks. First, maize prices collapsed in 2001, partly as a consequence of a glut that resulted from intensification of maize production in the 1990s. A drought soon followed, contributing to further reductions in cereal production (DSA 2006).

2. See Dercon and Hill (2009) and Dercon, Hill, and Zeitlin (2009) for further analysis of Ethiopia's recent growth episodes and long-term perspectives on this growth. Other chapters of this volume similarly deal with this topic.

FIGURE 4.1 Total and per capita grain production and grain yields, 1991/92–2007/08



SOURCE: Ethiopia, CSA (various years).
NOTE: *Grain* refers to all cereals, legumes, and pulses cultivated in Ethiopia.

The next episode might be described as a period of rapid agricultural growth. Following a recovery from the drought, agricultural GDP growth averaged 12 percent per annum between 2003/04 and 2007/08. But this growth period was paradoxically accompanied by a surge in food price inflation, which escalated from 2 percent in 2003/04 to 78 percent in 2007/08 (Mishra 2008; Ulimwengu, Workneh, and Paulos 2009) and raises a number of questions, including some pertaining to the quality of agricultural production statistics (Taffesse 2008; IFPRI 2009; Minot 2009).

These episodes raise the question of to what extent the policies governing Ethiopia's input markets and extension services have helped or hindered the country's agricultural intensification efforts over the past 15 years. Although the use of chemical fertilizer and improved seed has generally increased across these episodes (albeit from a low base level), the gains have been inconsistent and volatile. Part of this volatility may be attributable to the shifting roles of the public and private sectors and the occasional policy changes that have influenced their respective roles in different ways. Ethiopia's experiences over the past 15 years and the issues raised by these experiences are summarized in the next section for each of the major components of the country's agricultural input system and market—seed, fertilizer, and extension.

TABLE 4.2 Policy regimes and development programs in agricultural input systems and markets, 1995–present

Period	Intervention/event	Focus/objectives	Remarks
1991–95	Partial liberalization of the fertilizer market	Open the importation, wholesaling, and retailing of fertilizers to private companies.	Undertaken by the Transitional Government of Ethiopia. Fertilizer prices remained panterritorial and subsidized.
1993–99	Participatory Demonstration and Training Extension System (PADETES)	Promote improved seed-fertilizer-credit packages (primarily for maize and wheat) through a training and visit approach piloted by Sasakawa Global 2000.	PADETES demonstrated on a pilot basis that yields could be doubled with the application of modern inputs in Ethiopia.
1995–present	National Agricultural Extension Intervention Program	Scale up the PADETES approach to the national level as a means of boosting cereal yields and output.	Efforts to scale up the PADETES approach were less successful than the piloting demonstrated by Sasakawa Global 2000.
1997–98	Fertilizer price liberalization	Eliminate subsidies and deregulate the price of fertilizer at the wholesale and retail levels.	Liberal prices did not result in a competitive market due to the government's continued control over marketing and credit.
2000–07	Shifting industry structure	Private companies withdraw from the fertilizer market in 2000, succeeded by "holding" companies; cooperative unions enter the market in 2005, followed by the withdrawal of "holding" companies in 2007.	The Agricultural Input Supply Enterprise and cooperative unions emerged as the only actors engaged in fertilizer importation and were also the largest players in the wholesale and retail markets, in conjunction with the regional input supply and extension systems.

SOURCES: Demeke et al. (1998); Stepanek (1999); Gebremedhin, Hoekstra, and Tegegne (2006); Abate (2008); authors.

TABLE 4.3 Yields in on-farm field trials using improved seed and fertilizer versus farmers' yields using traditional cultivation practices, 1993–2008 (metric tons per hectare)

	SG2000 (1993–99)		NAEIP (1995–99)		Current farm yields (2000–08)
	Improved	Traditional	Improved	Traditional	
Maize	4.60	1.57	4.73	1.57	1.98
Wheat	2.31	0.95	2.93	1.17	1.47
Sorghum	2.08	0.92	2.79	1.12	1.40
Teff	1.62	0.64	1.43	0.85	0.93
Barley	n.a.	n.a.	2.15	1.00	1.19

SOURCE: World Bank 2006a.

NOTE: NAEIP = National Agricultural Extension Intervention Program; SG2000 = Sasakawa Global 2000 program; n.a. = not available.

Seed Systems and Markets

From a conceptual perspective, seed systems and markets are subject to at least three unique constraints that complicate early stages of seed market development. These constraints are contestable property rights relating to the improvement of cultivated varieties (cultivars), the absence of institutions for improved cultivars, and information asymmetries in the exchange of seed between buyers and sellers (Tripp and Louwaars 1997; Morris 1998; Gisselquist and Van Der Meer 2001; Hassan, Mekuria, and Mwangi 2001).

The first constraint emerges from the public goods nature of research embodied in improved cultivars and the inherent market failure that accompanies cultivar improvement. Consider a scenario in which a farmer saves and replants seed from an improved cultivar across seasons and, in doing so, avoids paying the private innovator who improved the cultivar for his or her investment in research and development (R&D). In other words, the innovator cannot recoup his investments in R&D due to the public good nature of the technology embedded in modern seed. This suggests that the public sector must play a continuous role in cultivar improvement by investing in agricultural R&D.

The second constraint is associated with mechanisms designed to increase the private innovator's capacity to recoup his or her investment in R&D and overcome the market failure described earlier. Biological mechanisms such as hybridization (common in the case of maize and increasingly in the cases of rice, millet, and sorghum) imply that farmers must purchase seed each season to reap the yield benefits of hybrids—the vigor conferred by heterosis. Institutional mechanisms such as intellectual property rights (plant-variety protection certificates, patents, and trade secrecy laws) similarly allow the innovator to recoup investment costs through litigation when a farmer plants improved cul-

tivars without paying some fee to the innovator for use of the seed. The inability to leverage the biological properties of hybrids, enforce intellectual property rights, or prevent farmers from saving seed can discourage private investment in cultivar improvements that have potentially significant social impacts, thus signaling another difficulty in correcting this market failure.

A third constraint emerges where the characteristics of improved seeds are known only by the innovator, implying that farmers are unable to make accurate ex ante assessments of quality, giving unscrupulous sellers an advantage over their customers. Remedies include strong regulation of the seed certification process or truth-in-labeling laws. Importantly, the absence of such regulations—or, worse yet, the wholesale deregulation of the seed sector as part of a wider market liberalization program—can inhibit smallholder adoption of improved cultivars (Tripp and Louwaars 1997).

In short, seed is a tricky good to manage due to inherent market failures that are difficult to overcome. We examine these issues in the context of Ethiopia's seed system and market, focusing on (1) the adoption of improved seed, (2) the demand for and supply of improved seed, and (3) the seed industry structure.

Improved Seed Adoption

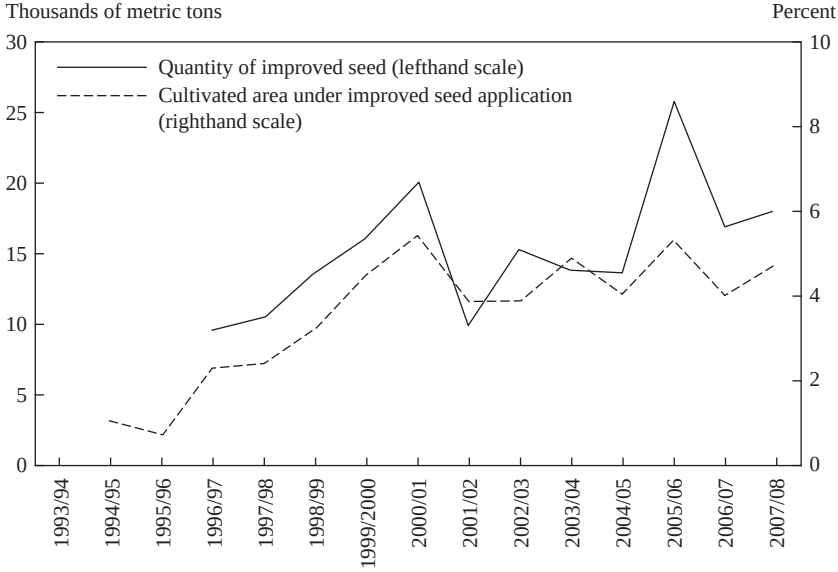
Official estimates from the Central Statistical Agency (CSA) show that although the total quantity of improved seed supplied nationally has been increasing since 1996–97, farmers' use of improved seed covered an average of only 4.7 percent of cropped area in 2007–08 (Figure 4.2).

Various surveys similarly report low adoption rates, for example, just 3 percent according to the nationally representative Ethiopia Rural Smallholder Survey (ERSS) conducted in 2005.[3]

To be sure, most farmers still rely primarily on farmer-to-farmer exchanges or on saved seed (Belay 2004). However, surveys such as these are often unable to provide real insights into improved seed adoption due to problems in their design. The question that should be asked is: what type of variety is a farmer cultivating, and when did he or she purchase the seed? For improved open-pollinated varieties such as wheat and teff, farmers do not necessarily need to purchase seed each season as they would hybrid maize. Rather, they might purchase seed every four to five years to replace their stocks of saved seed with

3. The ERSS was conducted by the International Food Policy Research Institute (IFPRI), Ethiopian Development Research Institute, and the CSA. Data were collected mid-2005 from 7,186 households randomly drawn from 293 enumeration areas (EAs, each roughly mapping to a *kebele*) based on a stratified two-stage cluster sample design. The sample is considered representative at the national level as well as at the regional level for four regions: Amhara, Oromiya, Tigray, and the Southern Nations, Nationalities, and People's Region (SNNPR). The ERSS survey was based on the CSA's Annual Agricultural Sample Survey, which used a sampling frame of 25 agricultural households selected from each EA and covered all of rural Ethiopia except Gambella region and the nonsedentary populations of three zones of Afar region and six zones of Somali region.

FIGURE 4.2 Area under improved seed application and quantity of improved seed distributed, cereals only, 1993/94–2007/08



SOURCE: Ethiopia, CSA (various years).

seed that has a higher level of purity and thus better performance when cultivated (Doss et al. 2003).[4]

To be sure, a large portion of wheat cultivated in Ethiopia is improved wheat. Lantican, Dubin, and Morris (2005) reported that in 2002, 71 percent of all wheat area in the country was sown with improved varieties. Beyene, Verkuijl, and Mwangi (1998); Kotu et al. (2000); and Zegeye (2001) reported that improved wheat adoption in selected *woredas* ranged from 42 to 80 percent during various years in the 1990s. Yet, as an indication of just how common long-term seed recycling is among Ethiopian smallholders, Lantican, Dubin, and Morris (2005) found that only 43 percent of the area under improved wheat varieties was sown with varieties released since 1995.

With respect to maize, CSA reports that the area under improved varieties and hybrids has grown from 5 percent in 1998 to 20 percent in 2008. Lantican, Dubin, and Morris (2005) report that, as of 2001, the majority of the improved maize was accounted for by hybrids. Degu et al. (2000); Zegeye and Haileye (2001); Zegeye, Tadesse, and Tesfaye (2001a, 2001b); and Zegeye et al. (2001)

4. Interestingly, a study by Bishaw (2004) indicates that the purity of and germination rates for farmer-saved wheat seed, seed purchased in local markets, and seed purchased or traded from neighbors is comparable to seed supplied by the government (R. Tripp, pers. comm.).

report that improved maize adoption in selected *woredas* ranged from 6 to 47 percent during various years in the 1990s. With respect to teff, barley, and sorghum, the other main cereal crops cultivated in Ethiopia, adoption rates have been relatively lower than for both wheat and maize (Figure 4.3).

In short, the conventionally cited figures—3 percent adoption of improved varieties and 4–5 percent of cropped area under improved varieties—obscure the extensive uptake of improved wheat and, to a lesser extent, improved maize, in Ethiopia. Moreover, these figures obscure the high rates of seed recycling and low rates of seed replacement, suggesting challenges for the promotion and adoption of new cultivars among smallholders.

Seed Demand and Supply

Estimates of market demand for improved seed in Ethiopia are based on official projections that are developed at the local (*kebele*) level and then transmitted through official channels to the zonal and regional levels, after which they are aggregated nationally to produce estimates of the type and quantity (but not preferences for specific varieties or traits) of seed that needs to be supplied in the coming season (Alemu et al. 2007).

The responsibility of responding to these demand estimates lies primarily with the state-owned Ethiopian Seed Enterprise (ESE). On the supply side, production and distribution of improved seed has been stagnant since about 2000. At about this same time, the supply of improved seed channeled through the regional extension and input supply system began to fall short of official estimates of demand (with a 72 percent shortfall in 2008 for the five major cereals). Limited production capacity at the ESE for certified seed, combined with insufficient provision of breeder and pre-basic seed from the research system, contributes much to these shortfalls.

Assuming that demand estimates are not wholly inaccurate, supply has consistently fallen short of demand, as shown in Table 4.4.[5]

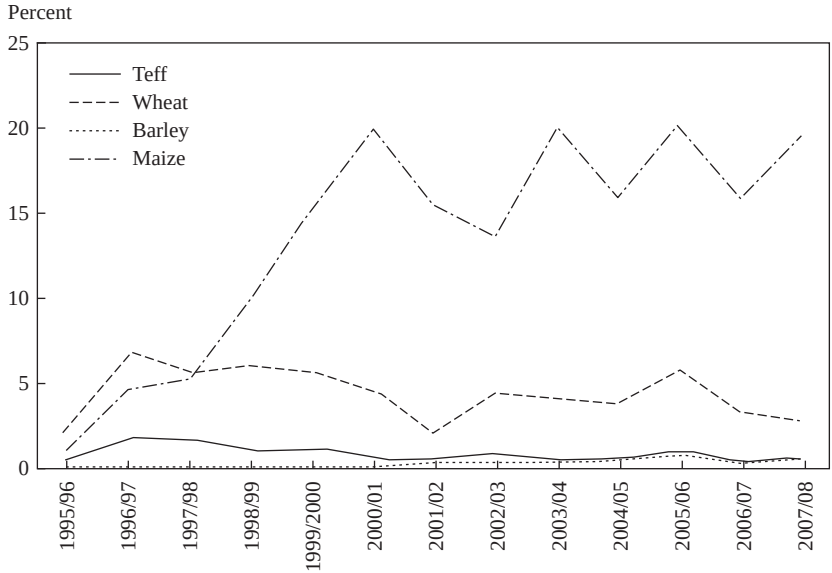
Shortcomings in seed quality and timeliness of delivery have also been long-standing issues in Ethiopia. Poor cleaning, broken seeds, low germination rates, and the presence of mixed seeds have been reported in ESE-supplied seed (DSA 2006). In addition, reports are common of seed being distributed after the optimal planting time or of varieties being distributed that are not appropriate to changes in farmers' expectations of seasonal weather conditions at the local level (Sahlu and Kahsay 2002; DSA 2006; EEA/EEPRI 2006).

Seed Industry Structure

Low adoption rates and shortfalls in the supply of improved cultivars can be partly attributed to bottlenecks emerging from the structure of the seed industry and the regulatory agencies that oversee it. We discuss the structure of the seed

5. More recently, supply has actually exceeded demand for hybrid maize seed due to changes in farmers' preferences at planting time, resulting in large carryover stocks of seed at ESE.

FIGURE 4.3 Area under improved seed application, main cereal crops, 1995/96–2007/08



SOURCE: Ethiopia, CSA (various years).

TABLE 4.4 Seed supply shortfalls in Ethiopia, 2005–08

	Supply as a percentage of official demand			
Crop	2005	2006	2007	2008
Wheat	20	38	23	24
Maize	53	28	60	48
Teff	5	12	22	19
Barley	16	18	10	7
Sorghum	n.a.	7	16	48

SOURCE: Ethiopia, MoARD (various years).

NOTE: n.a. = not available.

industry here in the context of hybrid maize, because experience from other industrialized and developing countries has shown that the hybrid maize business is one of the most lucrative seed businesses available to private innovators and investors, primarily due to the ability of innovators to recoup their investments in breeding due to the biological properties associated with hybridization, which make farmers' saving seed a relatively undesirable practice. That

said, many other cereal crops are critical to food security in Ethiopia, particularly wheat, teff, barley, and sorghum. To a great extent, the development and delivery of improved varieties of these crops rely on very different mechanisms within the seed system—systems that are more reliant on public-sector research and extension. But even with these crops, research, regulatory, production, and distribution bottlenecks are not insignificant, and many analytical insights from the maize seed system readily carry over to seed systems for these other crops.

The seed industry in Ethiopia involves a range of both public- and private-sector organizations (Figure 4.4; see also Bishaw, Sahlu, and Simane 2008). The national research system—headed by the Ethiopian Institute of Agricultural Research (EIAR) and comprised of a range of federal research centers, regional research centers, and agricultural universities and faculties—is charged with developing improved varieties and the breeder and pre-basic seed needed by other players in the industry. Regulatory functions such as varietal release reviews and seed certification are performed by various departments of the federal Ministry of Agriculture and Rural Development (MoARD).

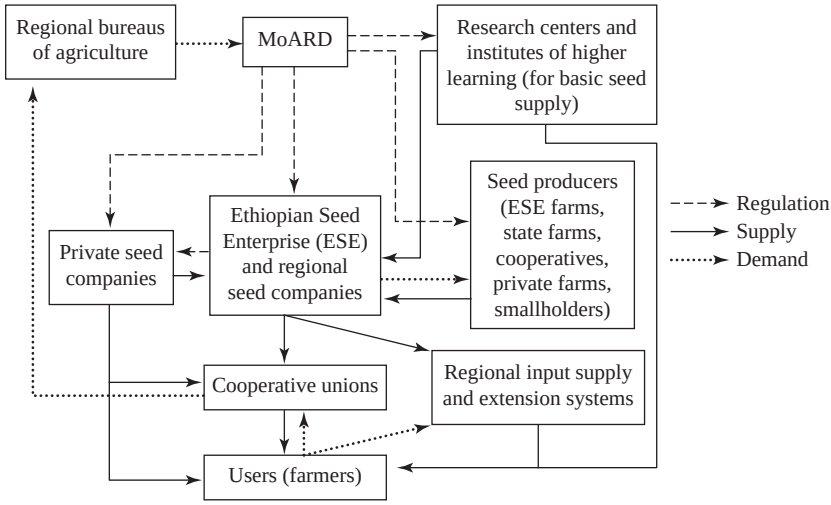
Basic and certified seed production is carried out by the ESE, which relies on its own farms alongside private companies, private subcontractors, state farms, and cooperatives to bulk up seed that is supplied to the regional extension and input supply systems. More recently, state-owned regional seed enterprises have also emerged in Oromiya and SNNPR (in 2008) and in Amhara (in 2009).

Improved certified seed is supplied to Ethiopian smallholders primarily through regional, state-run extension and input supply systems that operate with a degree of guidance from the MoARD. This regional system is made up of regional bureaus of agriculture and rural development (BoARDs), their *woreda* (district) offices, and extension agents (termed development agents in Ethiopia) working at the *kebele* level. These organizations collaborate closely with farmers' cooperatives and regional credit and savings institutions in both supplying inputs and disbursing credit.

Following market reforms in the 1990s, seed production and distribution were opened to the private sector (Figure 4.5). In 2004, 8 firms were active in seed production, with most of them involved specifically in hybrid maize seed, though primarily as ESE subcontractors (Alemu et al. 2007; Langyintuo et al. 2008). By 2008, the number of firms had increased to 11, although most were again operating primarily as ESE subcontractors. In some cases, these subcontractors also multiply seed for cooperatives, cooperative unions, and regional seed companies, although very few actually sell seed directly to farmers (with the exception of Pioneer Hi-Bred International and a few others).

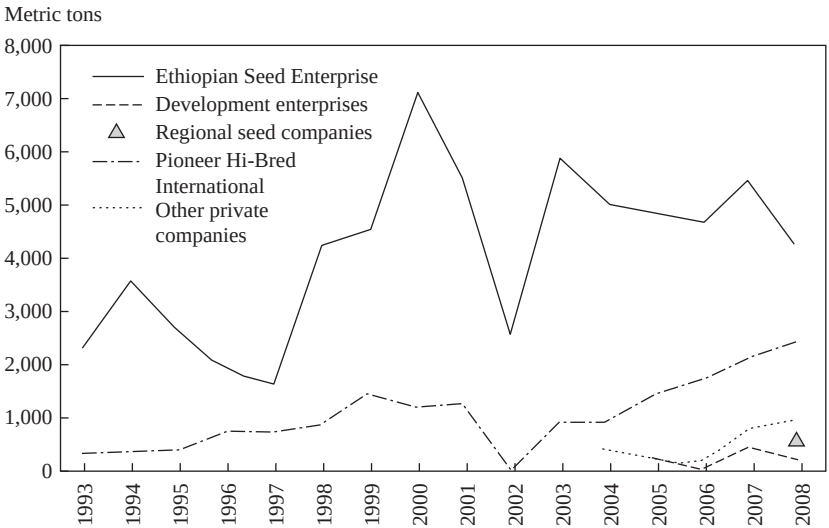
Despite the lucrative potential of the hybrid maize seed market—a potential that private seed companies have realized in other Sub-Saharan African countries—approximately 60 percent of maize seed was still controlled by the public sector (primarily the ESE and state-owned development enterprises), with an additional 10 percent serving as subcontractors to the public sector and

FIGURE 4.4 A schematic of the Ethiopian seed system



SOURCE: Authors.
NOTE: MoARD = Ministry of Agriculture and Rural Development.

FIGURE 4.5 Hybrid maize seed distribution, by type of supplier, 1993–2008



SOURCE: Ethiopia, MoARD (various years).

30 percent (Pioneer and a few small private companies) operating independent of the public sector's seed production system.

An even lower level of private-sector activity is seen on the distribution and retail side of the seed market. The public sector, including the regional extension and input supply systems, accounts for 80 percent of total sales of improved seeds, mostly paid for with credit disbursed against public guarantees (World Bank 2006b). Even Pioneer relies on the public sector to distribute about half of its seed, initially through the regional input and extension systems and, more recently, through cooperative unions. Most other seed firms simply produce as subcontractors to the ESE, which then distributes seed through the regional extension and input supply systems, cooperative unions, and its own branch offices, satellite stores, and sales points.

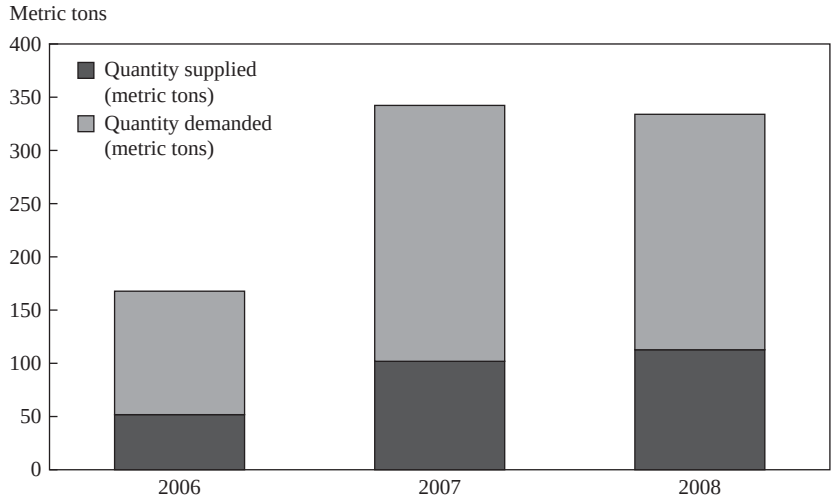
Why is the seed business so difficult to break into in Ethiopia? Here we examine the key barriers to entry.

First and foremost, the market failures that characterize seed markets (described earlier) constrain the potential for profitability. Hybrid maize stands out as the exception to this rule, because the gains conferred by hybridization can be secured by the farmer year by year only by purchasing new hybrid seed, while saving hybrid maize seed can result in yield losses of as much as 50 percent, depending on the hybrid type.

Second, the seed business depends on the availability of a good supply of high-quality pre-basic and basic seed for the production of certified seed that can then be distributed to farmers. The main sources of pre-basic and basic seed in Ethiopia are the federal and regional research centers and universities (with basic seed also produced by the ESE), and bottlenecks at these institutions create significant shortfalls in the availability of these key inputs (Figure 4.6). In some instances, these shortfalls have been exacerbated by research centers that are engaged not only in producing pre-basic and basic seed, but also in producing certified seed for farmers in areas surrounding the centers. Although the MoARD has taken action to rectify these problematic allocations of scarce seed system resources—for instance, by involving the ESE, private firms, and regional seed enterprises in the business of basic seed production—the pressure on the entire seed industry is not easily resolved (Ethiopia, MoARD 2008; A. Beshir, pers. comm.).

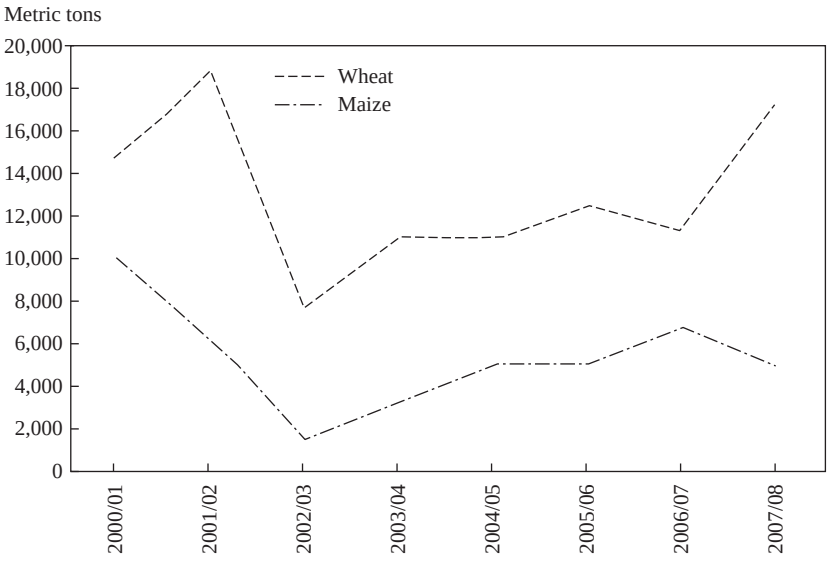
Third, the seed business is risky because seed production is closely correlated to the same weather risks faced by farmers. Hence, seed production in Ethiopia drops during drought periods just as crop production does (Figure 4.7). Having said this, seed production on irrigated land can mitigate this risk to some extent, and much of the ESE's maize seed production and subcontracted production currently take place on irrigated land in the Awash River basin. However, the shortage of irrigated land in Ethiopia makes reliable seed production a real challenge for both the public and the private sectors (Ethiopia, MoARD 2008).

FIGURE 4.6 Basic seed demand and supply for maize hybrid multiplication, 2006–08



SOURCE: Ethiopia, MoARD (various years).

FIGURE 4.7 Raw seed production, Ethiopian Seed Enterprise, 2000–08



SOURCE: Ethiopia, ESE (various years).

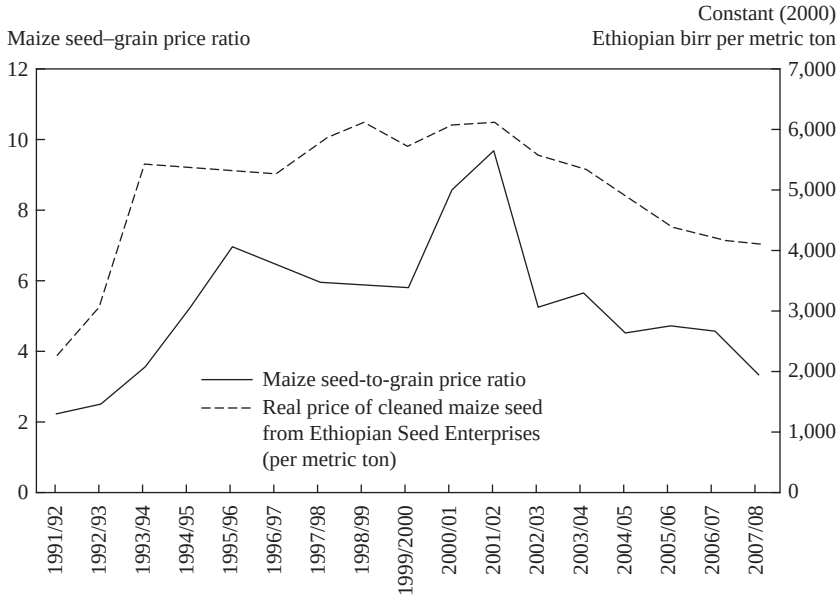
Fourth, the seed business is often dependent on smallholders themselves as contract growers for the ESE's seed multiplication activities, at least for open-pollinated crops such as lentils, chickpeas, haricot beans, and linseed (but not hybrids due to the technical complexity of hybrid seed production). In 2004/05, the ESE produced nearly 8,000 tons of seed through approximately 6,700 contract growers (Beshir 2005). The ESE pays a 15 percent premium over grain prices for quality seed grown by smallholders. However, changing grain prices—particularly low prices at harvesting time and higher prices at planting time—tempt farmers to default on their seed supply contracts with the ESE and hold the seed over for sale as grain to local traders and farmers at planting time. This frustrates the ESE's attempt to bulk up seed for certain crops.

Fifth is the issue of price. The ESE, the largest seed supplier in Ethiopia, prices its seed at a 5 percent profit margin. But for the industry to be viable, seed prices have to be high enough for private seed firms to recoup their investments in seed production without making seed unaffordable both to farmers who regularly use improved seed and to new adopters. Thus, the optimal seed price is based on the demand derived for the grain that is produced from that seed. A useful benchmark is the seed–grain price ratio which, in an emerging maize seed market such as Ethiopia's, might approach 5:1, eventually increasing to 10:1 as the market matures (Morris 1998). Moreover, seed–grain price ratios have fluctuated tremendously: upward with the collapse of maize prices in 2001–02, downward with the drought in 2002–03, and downward again to a ratio of 3.42:1 in 2007–08 (Figure 4.8). The volatility of these ratios suggests similarly volatile returns to investing in the maize seed business in Ethiopia, exacerbated by falling real prices for maize seed in the country.

Related to this volatility is the issue of retail pricing to farmers. In each region, cooperative unions are currently charged with distribution of seed sourced from ESE and other seed providers. Regional BoARDs set the price at cost plus transportation and a set profit margin, with some interregional variations in pricing policies. For example, Oromiya region's BoARD set a profit margin in 2008–09 at 2.5 percent for the cooperative union and 2.5 percent for the primary cooperative. This put the retail price of hybrid maize seed in Oromiya at approximately Ethiopian birr (ETB) 11,000 per ton, which, by comparison, was just 43 percent of Pioneer's price for hybrid maize seed, which was sold at ETB 19,200 per ton.

Yet, even Pioneer is marketing its products at relatively low prices by regional standards. This raises the issue of whether Pioneer or another competitor can develop and market a profitable product in Ethiopia. Anecdotal evidence from several sources indicates that the implicit rationing of hybrid maize seed has given rise to a black market in which repackaged (and potentially adulterated) seed sells for two to four times the retail price. This suggests that the market can bear a higher price, whether for hybrids suitable for the highlands, such as the ever-popular BH 660 produced by ESE and its subcontractors, or the hybrids suitable for mid-altitudes produced by Pioneer.

FIGURE 4.8 Hybrid maize seed–grain price ratios and real seed prices, 1991/92–2007/08



SOURCES: Ethiopia, ESE (various years); Ethiopia, MoARD (various years).

Efforts to use smallholders themselves as private agents in the multiplication of seed have met with limited success.[6] Though the technical requirements of maize hybrid multiplication (for example, the need for relatively large fields and means of controlling cross-pollination) might limit its applicability to small farmers in Ethiopia, there is potential for smallholders to play a larger role in multiplying open-pollinated crops (such as improved wheat varieties). Both the GoE and nongovernmental organizations have invested in various projects aimed at strengthening farmers' skills in seed multiplication, with the goal of increasing the supply of seed for improved varieties, both within communities and to the formal seed system. The outcomes to date have been mixed, partly due to poor incentives offered to farmers, insufficient capacity on both sides, and the constant threat of food insecurity, which causes farmers to use their seed stocks for food.

Finally, there is the issue of competitiveness. The public sector remains the main seed supplier in Ethiopia partly because it enjoys an implicit subsidy on both the production end (where high administrative costs do not figure into

6. For a review of Ethiopia's informal seed system and the role of farmer-based seed multiplication programs, see Thijssen et al. (2008).

calculations of the ESE's financial viability) and the marketing end (where cooperatives and regional, state-run extension and input supply systems handle distribution and retailing). To compete effectively with the public sector, private companies would have to build their own distribution and marketing networks, develop unique product lines that rival ESE products such as BH 660, establish their brand identities and reputations, provide agronomic services to support their customers, and price their products competitively. At present, only Pioneer markets its own product lines through a network of 15 dealers and through direct sales to state farms, commercial farms, cooperative unions, nongovernmental organizations, and warehouses (M. Admassu, pers. comm.).

Necessarily, as the maize seed industry in Ethiopia matures and companies begin releasing their own cultivars (rather than multiplying the cultivars already released by the EIAR), they will also have to contend with significant indirect costs. These costs include the costs associated with navigating the regulatory system, accessing financing from the formal banking sector, and meeting the banks' high collateral requirements. Thus, it is not surprising that Pioneer sells much of its output through official channels (formerly through the regional extension and input supply systems and more recently through the cooperative unions). Nor is it surprising that other, smaller private seed companies prefer to operate as ESE subcontractors or suppliers to cooperative unions rather than competitors.

In summary, the most lucrative of seed businesses—the hybrid maize business—has seen very little investment activity in Ethiopia, with far less investment flowing to seed businesses for other crops for which the challenges are even greater. Since the introduction of the National Seed Industry Policy in 1992, the GoE has pursued several policies favorable to private-sector development, such as the basic introduction of a legal framework for seed system operations (Proclamation 206/2000), the inclusion of commercial seed production as a sector under the Investment Code, and the enactment of legislation on breeders' rights and plant variety protection in 2006 (Proclamation 481/2006) (see Bishaw, Sahlu, and Simane 2008).

However, there is little likelihood that these policies will have the desired impact.[7] Opening commercial seed production to investors, for example, is a policy improvement that can go only so far in the absence of regulations allowing investors to access credit without nonagricultural collateral. Further, plant breeders' rights are only as effective as the sector they are meant to protect and only as strong as the commercial codes and the judicial system's capacity to enforce these rights. Moreover, there is only mixed empirical evidence from other developing countries to suggest that breeders' rights actually stimulate private-sector investment (see, for example, Butler and Marion 1985; Pray

7. For example, the administrative procedures necessary to implement the 2006 legislation on breeders' rights and plan variety protection have yet to be implemented.

1992; Alston and Venner 2000; Pray, Ramaswami, and Kelley 2001; Gerpacio 2003).

Finally, it is important to recognize that varietal improvement of many crops in Ethiopia, particularly open-pollinated crops such as wheat, will continue to depend on public breeding and seed production efforts, making the need for organizational reforms in the research system and seed sector as urgent as reforms in the policies governing the seed market itself. Improvement in the maize seed system may have positive spillover effects with respect to greater private investment in seed for these open-pollinated crops, but only to the extent that the public sector's breeding, seed production, and seed distribution systems are improved first.

Fertilizer Markets

Chemical fertilizer, a more obvious private good than seed, also possesses several features that complicate early stages of market development (Crawford et al. 2003; Morris et al. 2007). On the demand side, the cost of creating fertilizer markets is high where final consumers are widely dispersed geographically or where their small landholdings and limited cash resources mean that they purchase only small quantities of fertilizer, which are more costly for retailers to sell (Jayne et al. 2003; Harrigan 2008). Furthermore, in rainfed areas, fertilizer consumption is highly seasonal (with a two- to three-month market window), and year-to-year fluctuations in rainfall patterns contribute to high interyear variability in demand for fertilizer, with corresponding risks to dealers of high carryover stocks from year to year. On the supply side, the considerable economies of scale in international procurement and shipping imply that fertilizer importers require a high degree of liquidity to procure for the supply chain.

These characteristics suggest that although fertilizer may be a tradable private good, development of fertilizer markets may require some degree of public intervention in financing and market infrastructure development until markets mature. We examine these issues in the context of Ethiopia's fertilizer market, focusing on (1) the uptake of fertilizer, (2) fertilizer prices and profitability, and (3) the fertilizer industry structure.

Fertilizer Uptake

The uptake and use of chemical fertilizer in Ethiopia (primarily diammonium phosphate [DAP] and urea) can be assessed in several ways—in terms of total fertilizer imported, percentage of farmers using fertilizer and improved seed-fertilizer packages, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare. We examine these indicators next.

When measured in terms of quantity imported, fertilizer markets in Ethiopia responded remarkably well following the liberalization in the early 1990s.

Total consumption jumped from about 100,000 tons in 1993 to 300,000 tons in 2000, making the growth of Ethiopia's fertilizer consumption much faster than that in the average of Sub-Saharan African countries (Jayne et al. 2003; Crawford, Jayne, and Kelly 2006). Although it is now largely controlled by the Agricultural Input Supply Corporation (AISCO) and the cooperative unions, fertilizer imports in recent years have increased even faster—from their level in 2000 to 625,000 tons in 2009 (Figure 4.9).

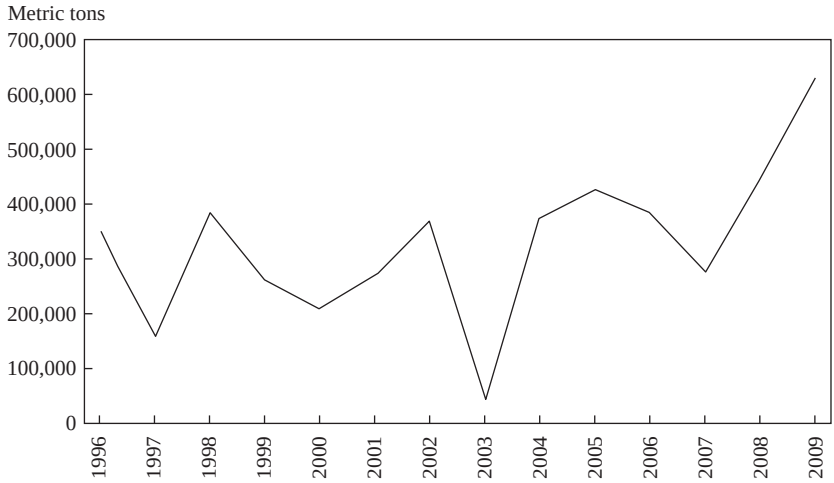
Data on fertilizer use suggest that a significant portion of smallholders use fertilizer: 39 percent according to CSA and 32 percent according to the 2005 ERSS. Teff, wheat, and maize cultivation account for the majority of fertilizer use.

However, data on application rates tell a slightly different, and often confusing, story about the intensity of fertilizer use in Ethiopia (Figure 4.10). Fertilizer use intensity, when measured in terms of kilograms per hectare of arable and permanent cropland, is currently estimated at 17 kilograms per hectare of nutrients (about 29 kilograms per hectare of commercial product), which is similar to application rates elsewhere in the region but considerably below the rates for comparable smallholder highland farms in neighboring Kenya (where fertilizer is applied to 70 percent of maize fields at an average dose for all fields of 45 kilograms per hectare) (Ariga et al. 2008). When measured in terms of kilograms/hectare of land under grain production, the figure increases to 21 kilograms per hectare of nutrients (about 37 kilograms per hectare of commercial product). And when measured in terms of kilograms per hectare of land under grain cultivation where fertilizer is applied (which accounts for 89 percent of all land cultivated in Ethiopia), the figure increases to 48 kilograms per hectare of nutrients (about 83 kilograms per hectare of commercial product), which begins to approach the application rates in Asia.

There is also evidence of increasing fertilizer use over time. Data from the 2004 and 2009 survey rounds of the Ethiopian Rural Household Survey (ERHS) (ERHS 2011), for example, show that between 2004 and 2009, the share of farmers who had used fertilizer at least once in the previous five years increased from 54.4 to 67.5 percent.[8]

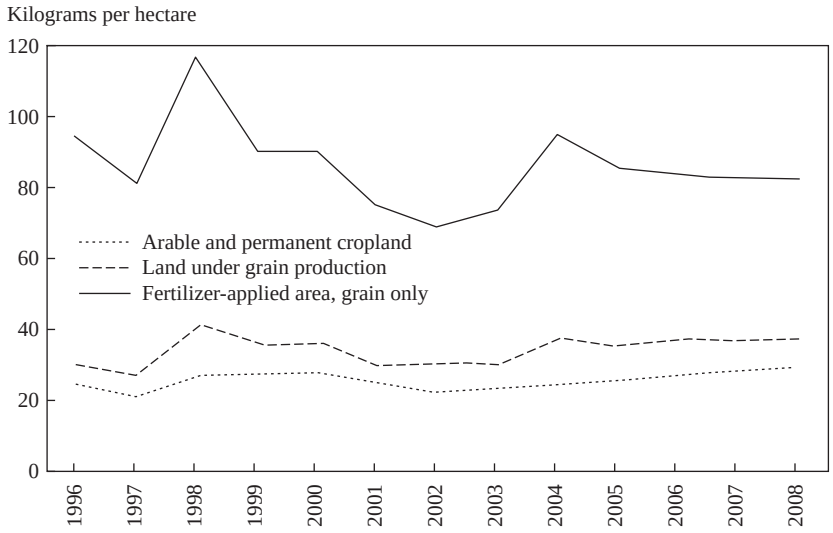
8. The ERHS is a longitudinal household survey that was first conducted in 1989 in seven peasant associations located in the regions Amhara, Oromiya, and the SNNPR. The survey collected consumption, asset, and income data on about 450 households and expanded its sample to cover 15 villages in 1994. Further rounds were conducted in 1995, 1997, 1999, 2004, and 2009, with coverage expanded to include 9 additional villages to capture the diversity in the country's farming system. The sample includes a total of 1,477 households. Topics addressed in the survey now include household characteristics, agriculture and livestock, food consumption, health, and women's activities, community-level electricity and water, sewage and toilet facilities, health services, education, nongovernmental organization activity, migration, wages, and production and marketing. The data were collected by the Economics Department, Addis Ababa University (AAU), the Centre for the Study of African Economies (CSAE), the University of Oxford, and IFPRI. See ERHS (2011).

FIGURE 4.9 Fertilizer imports, 1996–2008



SOURCE: Ethiopia, MoARD (various years).

FIGURE 4.10 Fertilizer use intensity, 1996–2008



SOURCES: Ethiopia, CSA (various years); Ethiopia, MoARD (various years).

However, there is also some evidence suggesting that these high fertilizer use intensity figures may be overstating the case. A study conducted by EEA/EEPRI (2006) notes that up to a third of farmers covered by PADETES have disadopted the seed-fertilizer technology packages over time, likely due to the high cost of inputs, insufficient credit and credit rationing, a lack of varieties with traits appropriate to farmers' needs, and other factors.

Fertilizer Prices and Profitability

We explore here the issue of fertilizer demand and supply in terms of the returns to fertilizer use, a subject of extensive discussion in Ethiopia. Estimates of the value–cost ratio (VCR) for four years between 1992 and 2008 are shown in Figure 4.11.[9] Assuming that fertilizer use is profitable where the VCR is greater than 2, the return to fertilizer use has been generally positive in recent years, with a VCR around the threshold of 2. And this holds true even when disaggregated by regional markets, except for the Arsi/Bale zone for teff and the Welega/Keffa zone for maize (Table 4.5).

However, given the high level of risk associated with rainfed agriculture and the variance of yield among farmers, it is likely that the VCR of fertilizer use needs to be significantly higher than the threshold level of 2 for fertilizer use to be profitable for most farmers. Furthermore, the VCR values themselves are accurate only to the extent that the 1989 and 1991 data on fertilizer trials, on which the VCR calculations are based, are robust case controls for all the relevant agricultural practices.

Still, these figures may broadly suggest that fertilizer prices in Ethiopia are competitive. Although the margin between domestic and international prices is higher in Ethiopia than in Asian and Latin American countries, it is still comparable to the margin in other Sub-Saharan African countries, including South Africa. And although the price buildup from port to farmgate is estimated at 26 percent (S. Rashid, pers. comm.), comparisons with other African countries indicate that marketing margins in Ethiopia are somewhat lower.[10]

In addition, fertilizer prices represent only one dimension of market performance. As in the case of seed, the ability to provide the right type of input of good quality to farmers in a timely manner is equally important. The distribution system in Ethiopia is inflexible, providing only two types of fertilizer (DAP and urea), both in 50-kilogram bags. Moreover, in recent years numerous farmers (as many as half in some regions) have consistently reported late delivery of fertilizer.

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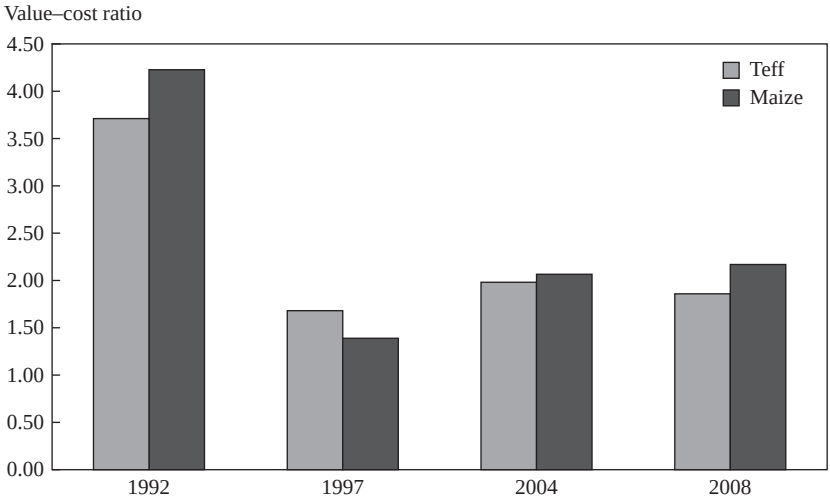
9. Value–cost ratio (VCR) is the change in revenue due to fertilizer use at the recommended level in a given plot of land. In notation it is given by $VCR = (\Delta y \cdot p)/Cf$, where Δy denotes incremental yield gains resulting from fertilizer use, p denotes output price per kilogram, and Cf denotes the cost of fertilizer.

10. The price buildup for fertilizer estimated here is specifically for fertilizer imported through Djibouti, transported to Adama, distributed to cooperative unions, distributed onward to primary cooperatives, and eventually sold to farmers.

FIGURE 4.11 Fertilizer value–cost ratios, 1992, 1997, 2004, and 2008



SOURCES: For 1992 and 1997, Demeke (1997); for 2004 and 2008, authors' calculations.

A study of Ethiopian smallholders by Bonger, Ayele, and Kuma (2004) found that half of the farmers surveyed for the study reported that fertilizer arrived after planting, while 32 percent reported underweight bags, 25 percent complained of poor quality, and almost 40 percent reported that their planting was delayed by fertilizer problems. Studies by DSA (2006) and EEA/EEPRI (2006) found that although fertilizer quality problems had been reduced in recent years, delays in delivery were still common, with 25 percent or more of farmers complaining of late delivery.

Data from the 2004 and 2009 rounds of the ERHS (ERHS 2011) provide further insight into these problems, with surveyed farmers ranking the four major problems in Ethiopia's fertilizer supply system as follows: high price, late arrival, shortage of supply, and lack of credit (Table 4.6). Analysis of these results also provides a reflection on farmers' perceptions of the link between fertilizer use and output: in 2004, 30 percent of the 1,350 surveyed farmers in 15 villages reported that their output was affected by not being able to obtain fertilizer at the right time. This figure decreased to 20 percent in the 2009 survey round.

Still, other problems remain. Unlike neighboring countries such as Kenya, Ethiopia does not offer fertilizer in smaller packages that could be used by smallholders or in different formulations needed for different types of agro-climates, soils, and crops.

In addition, input distribution tied to credit tends to limit the space available for the emergence of private-sector retailers. The state's guaranteed loan program with preferential interest rates creates an uneven playing field in the rural finance sector by undermining efforts to set up alternative institutions such

TABLE 4.5 Fertilizer value–cost ratios, 1992–2008

	1992				1997				2004				2008			
Crop, zone	C_f (ETB/ dose)	Δy (kg/ ha)	P (ETB/ kg)	*VCR*	C_f (ETB/ dose)	Δy (kg/ ha)	P (ETB/ kg)	*VCR*	C_f (ETB/ dose)	Δy (kg/ ha)	P (ETB/ kg)	*VCR*	C_f (ETB/ dose)	Δy (kg/ ha)	P (ETB/ kg)	*VCR*
Teff																
Shewa	212	641	1.22	3.69	516	641	1.35	1.67	601	641	1.80	1.92	1,465	641	4.36	1.91
Gojam	197	592	1.22	3.66	480	592	1.35	1.66	587	592	2.10	2.12	1,387	592	4.67	1.99
Arsi/Bale	160	473	1.22	3.6	391	473	1.35	1.63	459	473	1.80	1.85	1,224	473	4.36	1.69
Across the country	192	590	1.22	3.74	468	590	1.35	1.69	565	590	1.93	2.02	1,374	590	4.44	1.91
Maize																
Shewa	194	1,325	0.65	4.44	472	1,325	0.53	1.48	548	1,325	0.95	2.30	1,346	1,325	2.32	2.28
Gojam	296	1,932	0.65	4.24	720	1,932	0.53	1.41	874	1,932	1.22	2.69	2,084	1,932	2.61	2.42
Welega/Kefa	314	1,855	0.65	3.84	765	1,855	0.53	1.28	974	1,855	0.95	1.81	2,347	1,855	2.32	1.83
Gamu																
Gofa/Sidamo	191	1,212	0.65	4.13	463	1,212	0.53	1.38	543	1,212	0.77	1.73	n.a.	1,212	2.30	n.a.
Across the country	216	1,410	0.65	4.24	526	1,410	0.53	1.41	633	1,410	0.95	2.12	1,556	1,410	2.41	2.18

SOURCES: For 1992 and 1997, Demeke (1997); for 2004 and 2008, authors' calculations.

NOTES: The value–cost ratio is calculated as $VCR = (\Delta y \cdot p)/Cf$, where Δy denotes incremental yield gains resulting from fertilizer use, p denotes output price per kilogram, and Cf denotes the cost per recommended dose of fertilizer for 1 hectare of land. Fertilizer recommendation (dose) and response rate were taken from fertilizer trials conducted in 1989 and 1991 by the Ministry of Agriculture and the National Fertilizer and Inputs Unit. ETB = Ethiopian birr; ha = hectares; kg = kilograms; n.a. = not available.

TABLE 4.6 Major problems of the fertilizer supply system, 2004 and 2009

Problem with the fertilizer supply system	2004 Percentage of people who ranked the problem:			2009 Percentage of people who ranked the problem:		
	1st	2nd	3rd	1st	2nd	3rd
High price	47.6	30.6	32.3	50.3	30.9	13.3
Late arrival	9.6	34.6	12.2	11.7	30.0	25.4
Shortage of supply	15.2	11.1	22.9	11.1	13.2	18.3
Lack of credit	3.2	17.7	27.12	5.0	31.0	35.4

SOURCE: Authors' computations based on the 2004 and 2009 rounds of the Ethiopian Rural Household Survey (ERHS 2011).

as microfinance organizations, branches of commercial banks, or independent financial cooperatives.

Loan recovery with the use of extension agents and a degree of coercion by local administrative officials were generally successful until the collapse of maize prices in 2001 and the subsequent drought. In Oromiya region, for example, credit recoveries had averaged above 80 percent up to 2001, but this figure dropped to 60 percent in 2002, forcing a major rescheduling of loans. This has resulted in high fiscal costs and fiscal risks associated with the loan guarantee program. The write-off to loan guarantees amounted to ETB 84 million in 2001, but by 2005 liabilities had again accumulated to ETB 183 million (DSA 2006). Also in 2005, Oromiya region was obliged to pay approximately ETB 84 million to the Commercial Bank of Ethiopia to honor its guarantees for the previous three-year period. The guarantee thus becomes a subsidy that is not accounted for in government budgeting.

Beyond fiscal costs, there are also considerable but nonquantifiable implicit costs in the system, many of which are borne by the government through its regional extension and input supply systems. These include the costs resulting from the "central planning" system of demand estimation, which is similar to that described earlier for seed. The indirect costs also include the costs of storage and quality deterioration incurred because closing stocks have comprised 50 percent or more of total consumption in most years except 2004 and 2005. Finally, the implicit costs include those resulting from damage done to extension–farmer relationships when harsh measures have been employed to ensure loan repayment.

Fertilizer Market Structure

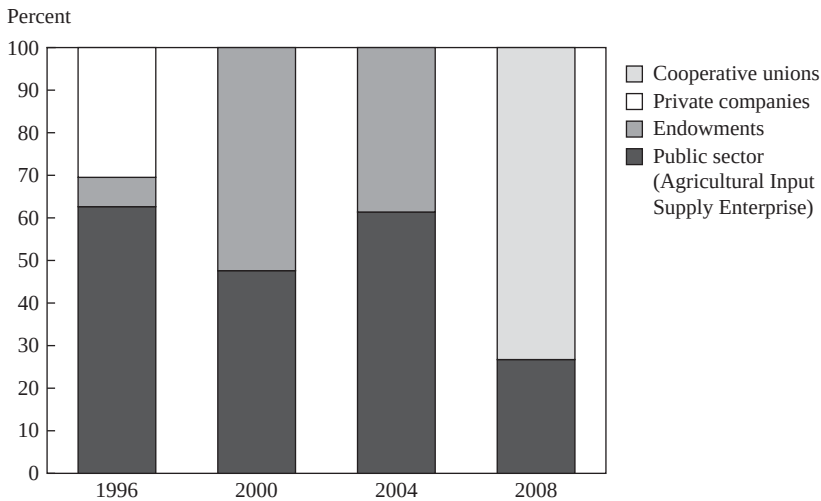
Fertilizer use intensity, demand, and supply, discussed earlier, are closely tied to the changing structure of Ethiopia's fertilizer market. The GoE liberalized

the fertilizer sector soon after the end of the Derg regime. The first reforms occurred in the early 1990s with the privatization and abolishment of the monopoly on fertilizer importation and distribution held by the state-owned AISCO, later renamed the Agricultural Input Supply Enterprise (AISE). Policy changes that fully liberalized fertilizer pricing and the removal of subsidies followed in 1997–98. The private sector's initial response to market liberalization was rapid. Although there were only three large importers, there was very rapid growth in private wholesalers and retailers in the country. One company, Ambassel, had 103 wholesalers, 901 retailers, and 860 service cooperatives by 1996 (Demeke et al. 1998).

Unfortunately, there are few empirical data and little analysis against which to assess the private sector's performance during this initial round of reforms. This is due to the fact that the independent private sector rapidly exited the fertilizer market within a few years of its entry. In the case of imports, the share of private firms operating in the market went from 33 percent in 1995 to zero in 1999. These firms were first replaced by "private" holding companies with strong ties to government (Jayne et al. 2003). Since 2007, fertilizer imports have been controlled by the AISE and cooperative unions (Figure 4.12).

The market share trends are similar in the case of wholesalers. Although the AISE had a market share of less than 50 percent during the middle and late 1990s, it had regained the majority share by 2001, when private-sector wholesalers, except for the holding companies, had disappeared from the scene. In

FIGURE 4.12 Fertilizer import shares, by type of importer, 1996–2008



SOURCE: Ethiopia, MoARD (various years).
NOTE: *Endowments* denotes the holding companies described in the text and by Jayne et al. (2003).

the retail market, the decline was even more dramatic. Although private retailers held a majority share of the market in the early 1990s, the public sector and cooperative unions have become almost the sole distributors of fertilizer since 2000 (DSA 2006). As of 2004, the public sector accounted for over 70 percent of distribution, with private dealers accounting for only 7 percent of sales nationwide (EEA/EEPRI 2006). The public-sector supply channels have also changed; whereas extension agents initially managed distribution, the responsibility was shifted to *woreda* input supply offices and cooperatives in more recent years.

The decline in private-sector participation in fertilizer markets reflects several factors, including difficulties in the import process itself. Importing fertilizer requires that the importer obtain a license that is allocated by the GoE through a tendering process and that fertilizer be imported in lots of 25,000 tons. The importer almost always requires financing given that a single shipment of fertilizer alone requires over $5–10 million over several months. A private-sector buyer is currently required to deposit 100 percent of the value of the fertilizer to be imported at the time a line of credit is opened. What remains to be clearly understood is whether these same requirements apply to the AISE, holding companies, and cooperative unions. If these actors in the fertilizer market enjoy privileged collateral requirements, this would suggest an uneven playing field and would be a clear indicator of the private sector's total exit from the fertilizer market.

Agricultural Extension Services

In effect, agricultural extension services are what tie improved seed, chemical fertilizers, and credit together for the Ethiopian smallholder. Extension services were first introduced in 1953 by the Imperial Ethiopian College of Agricultural and Mechanical Arts (also known as Alemaya University and recently renamed Haramaya University) in the style of a US land grant university. Extension services were later provided to a larger number of farmers in the 1960s under the comprehensive integrated package projects, described earlier. In the 1980s, the extension system jumped on the bandwagon and transformed itself into a training and visit (T&V)–style system that was favored by the international donor community at the time (Abate 2008).

The PADETES program described earlier worked with this T&V approach to specifically promote improved seed and chemical fertilizer and succeeded in convincing the GoE to expand its coverage under the NAEIP in 1995. The PADETES/NAEIP programs are credited with expanding the reach of Ethiopia's extension services to some 9 million farmers by 2007–08 (Adugna 2008).

Over the past five years, the federal and regional extension programs have increased the number of public extension staff three-fold—from approximately 15,000 development agents (DAs) during the PADETES/NAEIP period to more

TABLE 4.7 Development agents and farmer training centers, 2008

Region	Farmer training centers (FTCs)			Development agents (DAs)								
				Crop development		Livestock		Natural resource management		Other		Total DAs
	FTCs required (number of *kebeles*)	FTCs established as of 2008	Total fully functional FTCs	Male	Female	Male	Female	Male	Female	Male	Female	
Tigray	602	588	55	544	65	526	52	574	29	235	42	2,067
Oromiya	6,420	2,549	1,147	5,885		6,021		6,080		1,668		19,654
Amhara	3,150	1,725	318	2,407	464	2,438	493	2,597	318	90	1,389	10,196
SNNPR	3,681	1,610	857	13,448[a]								13,448
Afar	558	n.a.	n.a.	240		241		209		58		748
Somali	n.a.	2	n.a.	422	26	376	32	334	40	35	4	1,269
Harari	17	5	3	15	n.a.	15	3	15	2	2	n.a.	52
Dire Dawa	25	7	n.a.	22	2	14	4	18	4	19	5	88
Total	14,453	6,486	2,380	3,410	557	3,369	584	3,538	393	381	1,440	47,522

SOURCE: MoARD 2009.

NOTE: SNNPR = Southern Nations, Nationalities, and People's Region; n.a. = not available.

[a]Data for the SNNPR are based on figures from 2006–07.

than 47,500 in 2008 (Table 4.7). This rapid expansion has been the linchpin of the GoE's effort to accelerate agricultural production and productivity growth, and it has been accompanied by the establishment of farmer training centers (FTCs), each of which is meant to house three DAs with a range of technical skills and to provide a broad range of demand-responsive extension and short-term training services.

Agricultural extension services in Ethiopia have traditionally been financed and provided almost entirely by the public sector. Thus, these programs represent a significant public investment, amounting to over $50 million dollars, which is roughly equivalent to 2 percent of total annual government expenditure.

Real progress on the ground has been mixed with respect to DA deployment and FTC start-ups (see Table 4.7). DA recruitment and training have largely succeeded in meeting their numeric targets, although FTC start-ups have lagged behind. Meanwhile, the expected impact of DAs and FTCs remains unclear, due in part to the near absence of any rigorous impact evaluation, even though the significant amount of resources dedicated to the extension system warrants such evaluation.

All this said, four previous studies that evaluate the contribution of agricultural extension in Ethiopia are worth noting. First is the EEA/EEPRI (2006) evaluation of PADETES, which is referred to throughout this chapter. Second is Bonger, Ayele, and Kuma (2004), also referred to herein. Third is a recent impact evaluation of Ethiopia's Productive Safety Net Programme (PSNP) by Gilligan, Hoddinott, and Taffesse (2008), which reports the positive impact on a range of food security and poverty indicators of income earned from public works activities undertaken by food-insecure households through the PSNP when combined with the "Other Food Security Program," which provides access to improved seed, extension services, and natural resource management schemes. Fourth is a study based on panel data from the Ethiopian Rural Household Survey by Dercon et al. (2009) that reports the significant effect of extension workers' visits on poverty headcounts and consumption growth between 1994 and 2004.

Nonetheless, the entire body of evidence on agricultural extension suggests that its impact on productivity and poverty has been mixed to date. Although many farmers seem to have adopted the packages promoted by the extension system, up to a third of the farmers who have tried a package have discontinued its use (Bonger, Ayele, and Kuma 2004; EEA/EEPRI 2006). Indeed, Bonger, Ayele, and Kuma (2004) also find that poor extension services were ranked as the top reason for nonadoption.

Part of the problem is that the success of the extension services has traditionally been measured in terms of numeric targets for physical input use, instead of emphasizing the efficiency and profitability of input use. In fact, most extension agents view their role primarily as distributing fertilizer and credit, a role that hampers the provision of technical advice (EEA/EEPRI 2006).

The hierarchical "culture" underlying the extension system does little to encourage and exploit the inherent resourcefulness of those who work closely with farmers and rural communities (Gebremedhin, Hoekstra, and Tegegne 2006; Davis et al. 2007). And although extension has been decentralized to the administrative control of regional governments and *woreda* administrations, continued imposition of targets from above and weak local capacity have not yet permitted the emergence of a dynamic demand-driven system.

On the positive side, several reforms have been introduced to address these deficiencies. First, in an effort to get beyond a focus on cereals, new packages have been developed to support other crop and livestock enterprises, improve postharvest technology adoption, and encourage natural resource management. Second, in recognition of the diversity of smallholder farming systems in Ethiopia, classifications have been developed to divide the country into several distinct agroecological zones to aid in the development of more appropriate zone-specific packages (Ibrahim 2004). Third, input distribution is being shifted away from extension services to cooperatives, thus freeing extension agents to provide more technical advice. Finally, moves are being made to strengthen and diversify the curriculum provided by the 25 Agricultural Technical and Vocational Education and Training colleges that are responsible for preparing DAs for deployment throughout the country (Table 4.8).

Some small improvements in the extension system have been recorded in recent years. Data from the 2004 and 2009 survey rounds of the ERHS (ERHS 2011) suggest that although only 25 percent of the farmers surveyed in 2004 had been visited by a development agent at least once in the previous (main) growing season, this figure had increased to 46 percent in 2009 (Table 4.9). Of course, the frequency of extension contact says little about the nature, quality, and effectiveness of the extension system itself, further suggesting the need for in-depth evaluation.

Conclusions

After nearly two decades of policies that placed a high priority on boosting agricultural production and productivity, Ethiopia has seen some amount of success. But many persistent and unsolved challenges remain. There is little doubt that intensification and commercialization of agriculture are needed in Ethiopia given its precarious food situation and acute land scarcity. The challenge is finding ways to strengthen smallholders' access to inputs, technology, and information and improving the incentives for their use and adoption, all within highly heterogeneous agroecologies characterized by high risks.

State-led policies to promote improved seed and fertilizer through regional state-run input supply and extension systems initially generated some positive impacts in Ethiopia over the past two decades. But experience to date suggests that increasing the role of the state will not provide the intended growth stimu-

TABLE 4.8 Agricultural Technical and Vocational Education and Training (ATVET) college graduates, 2003–04 to 2007–08

Year	Number of ATVET graduates
2003–04	9,368
2004–05	13,899
2005–06	11,095
2006–07	15,099
2007–08	9,404
Total	59,364

SOURCE: Ethiopia, MoARD (2009).

TABLE 4.9 Frequency of visits by an extension agent during the previous main growing season, 2004 and 2009

	2004			2009		
Number of times visited	Number of farmers	Percent	Cumulative	Number of farmers	Percent	Cumulative
0	910	75.3	75.3	841	53.5	53.5
1	58	4.8	80.1	180	11.5	65.0
2	89	7.4	87.5	235	15.0	79.9
3	54	4.5	92.0	160	10.2	90.9
≥ 4	97	8.0	100.0	58	9.2	100.0
Total number of farmers	1,208			1,570		

SOURCE: Authors' computations based on the 2004 and 2009 rounds of the Ethiopian Rural Household Survey (ERHS 2011).

lus to the agricultural sector. The current approach reduces the quality of input services to smallholders, incurs many hidden costs to the government, and generates significant risks to both smallholders and the government.

This is not to say that the public provision of information, input, credit, and administration is unnecessary. Rather, public-sector involvement in Ethiopia's agricultural sector will remain critical where smallholders have poor access to markets, weak purchasing power, and asymmetrical access to market information. Moreover, public leadership in encouraging private investment in market-based systems remains necessary in Ethiopia, where modern market institutions are still underdeveloped.

Nonetheless, more consideration should be given to long-term policies designed to build a dynamic private sector to promote fertilizer, seed, credit, and market information systems. A greater degree of flexibility in how inputs

and services are provided and a greater degree of choice for smallholders can open up new market and technological opportunities in the agricultural sector.

Thus, the development of an efficient input marketing and rural financial system will be a difficult, time-consuming, and expensive undertaking that will require significant support for institution-building activities, capacity strengthening and training, and financial-sector infrastructure development. Several measures would facilitate the transition.

First, policies to open the market (and pricing) for hybrid maize seed—taking a page from successful experiences in the region—should be explored more actively. This transition would have to be gradual. The ESE's capacity to produce seed during a transition into privatization could drop dramatically, while private seed multipliers aiming to fill the gap would struggle to expand into upstream breeding activities, scale up multiplication, and build their distribution and retailing networks. But if reforms were accompanied by new procurement procedures that encouraged cooperatives and the regional extension and input supply systems to purchase seed more extensively from the private sector and if commercial lending was made more readily available to encourage private seed companies to expand their production and distribution, smallholders could benefit from a larger choice and a better quality of maize seed. There are positive signs suggesting that both the government and other stakeholders are pursuing such reforms with support from the donor community; however, close monitoring of the reform's progress remains vital to success.

Second, policies to liberalize the fertilizer market should be pursued. These should include policies for liberalizing collateral requirements for fertilizer imports and reducing the credit guarantee to 50 percent, then gradually lowering it further until an eventual phase-out; opening the credit guarantee to other certified financial institutions; and liberalizing interest rates. In the short term, risk-averse commercial banks might shy away from financing fertilizer imports and distribution. However, with the long-run development of a liberalized and competitive financial sector, these short-term issues would likely give way to greater investment in fertilizer importation and distribution.

Third, deep reforms in the extension system should be explored sooner rather than later. Such reforms would need to move the system away from single-minded, top-down, package approaches to cereal intensification to more dynamic, responsive, and competitive service provision. These approaches will require greater flexibility within the current system, which can be accomplished only by investing time, effort, and resources in changing the cultures and practices of the extension system, and they are likely to yield results over a much longer-term period. However, without such changes, the extension and education system in Ethiopia will become increasingly irrelevant to the needs of intensive commercial smallholder production systems. Again, the signs suggest that the government is pursuing reforms in this area, although close monitoring of progress is vital to success.

Fourth, innovative programs should be continually explored. Given the risks posed by production and price variability in Ethiopia, price risk mitigation based on a combination of market and nonmarket management tools should also be a major policy priority for the country. Nonmarket-based options will work in the short term only if combined with long-term improvements in physical infrastructure, information and communications technology, contract enforcement, and strengthening of the markets for credit and insurance. Innovative programs would include investments to scale up the weather insurance schemes currently being piloted, develop a comprehensive market information system to support the new commodity exchange, and liberalize the telecommunications sector to improve rural access to information and communications technologies.

Finally, significantly more resources should be invested in regular and methodical assessments of the impact of the extension and input supply system. The near absence of independent impact assessment makes it difficult to evaluate where in the system there are disincentives, bottlenecks, and structural issues and how they can be remedied.

These findings reinforce those of other studies conducted in the region of the need for complete rather than half-hearted liberalization of input supply markets to support smallholders' efforts to intensify cereal production. Moreover, these recommendations detail the intricacies of the liberalization process and the need to be deeply aware of the peculiarities—both the inherent market failures and the potential profit opportunities—that describe input markets and extension services. Finally, the findings recognize the necessity of both continuing public engagement in input markets and extension services and carving out new space for private investment in providing goods and services for smallholders in a potentially efficient manner.

In conclusion, although Ethiopia has an admirable record of supporting agriculture, the continued state-led policies to boost agricultural production and productivity have now outlived their usefulness. A rethinking of approaches is needed, one that reallocates the roles of the public and private sectors in the promotion and regulation of the agricultural input sector. This rethinking requires a nuanced understanding of the complex issues involved, evidence-based analysis and policy recommendations, and continuous debate on the pros and cons of alternatives and options. Lessons learned from this process can do much to inform Ethiopia's long-term development strategy.

References

Aalen, L. 2002. *Ethnic Federalism in a Dominant Party State: The Ethiopian Experience, 1991–2000.* Report R2002:2. Bergen, Norway: Chr. Michelsen Institute.

Abate, H. 2008. *Key Messages from a Study on Ethiopia's Extension Systems.* Addis Ababa, Ethiopia: Food and Agriculture Organization of the United Nations Subregional Office for Eastern Africa.

Adugna, T. 2008. "PASDEP Progress Report." Presentation on the Rural Economic Development and Food Security program in Ethiopia. Addis Ababa, November 10.

Alemu, D., W. Mwangi, M. Nigussie, and D. J. Spielman. 2007. *An Analysis of Maize Seed Production and Distribution Systems in Ethiopia's Rift Valley.* Ethiopian Institute of Agricultural Research (EIAR) Research Report 72. Addis Ababa, Ethiopia: EIAR.

Alston, J. M., and R. J. Venner. 2000. *The Effects of the U.S. Plant Variety Protection Act on Wheat Genetic Improvement.* Environment and Production Technology Division Discussion Paper 62. Washington, DC: International Food Policy Research Institute.

Ariga, J., T. S. Jayne, B. Kibaara, and J. K. Nyoro. 2008. "Trends and Patterns in Fertilizer Use by Smallholder Farmers in Kenya, 1997–2007." Tegemeo Institute of Agricultural Policy and Development, Egerton University, Egerton, Kenya. Mimeo.

Belay, S. 2004. *The Seed Regulations and Standards of Ethiopia: The Way Forward.* Eastern and Central Africa Program for Agricultural Policy Analysis (ECAPAPA) Report. Entebbe, Uganda: ECAPAPA.

Beshir, A. 2005. "Farmer-Based Seed Production an Alternative for Seed Security: The Ethiopian Experience." *Seed Info* 29: 8–10.

Beyene, H., H. Verkuijl, and W. Mwangi. 1998. *Farmers' Seed Sources and Management of Bread Wheat in the Wolmera Woreda, Ethiopia.* Mexico City and Addis Ababa, Ethiopia: CIMMYT and Institute of Agricultural Research.

Bishaw, Z. 2004. "Wheat and Barley Seed Systems in Ethiopia and Syria." PhD thesis, Wageningen University, Wageningen, the Netherlands. Accessed May 15, 2011. http://library.wur.nl/wda/dissertations/dis3575.pdf.

Bishaw, Z., Y. Sahlu, and B. Simane. 2008. "The Status of the Ethiopian Seed Industry." In *Farmers, Seeds, and Varieties: Supporting Informal Seed Supply in Ethiopia*, ed. M. H. Thijssen, Z. Bishaw, A. Beshir, and W. S. de Boef. Wageningen, the Netherlands: Wageningen International.

Bonger, T., G. Ayele, and T. Kuma. 2004. *Agricultural Extension, Adoption, and Diffusion in Ethiopia*. Ethiopian Development Research Institute (EDRI) Research Report 1. Addis Ababa, Ethiopia: EDRI.

Butler, L., and B. Marion. 1985. *The Impacts of Patent Protection on the U.S. Seed Industry and Public Plant Breeding.* North Central Region Research Publication 304, North Central Project 117, Monograph 16. Madison, WI, US: Research Division, College of Agricultural and Life Sciences, University of Wisconsin.

Crawford, E. W., T. S. Jayne, and V. A. Kelly. 2006. *Alternative Approaches to Promoting Fertilizer Use in Africa.* Agriculture and Rural Development Discussion Paper 22. Washington, DC: World Bank.

Crawford, E., V. Kelly, T. S. Jayne, and J. Howard. 2003. "Input Use and Market Development in Sub-Saharan Africa: An Overview." *Food Policy* 28 (4): 277–292.

Davis, K. E., J. Ekboir, W. Mekasha, C.M.O. Ochieng, D. J. Spielman, and E. Zerfu. 2007. *Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective: Case Studies of Ethiopia and Mozambique.* IFPRI Discussion Paper 736. Washington, DC: International Food Policy Research Institute.

Degu, G., W. Mwangi, H. Verkuijl, and A. Wondimu. 2000. *An Assessment of the Adoption of Seed and Fertilizer Packages and the Role of Credit in Smallholder Maize Production in Sidama and North Omo Zones, Ethiopia.* Addis Ababa, Ethiopia, and Mexico City: Ethiopian Agricultural Research Organization and CIMMYT.

Demeke, M., V. Kelly, T. S. Jayne, A. Said, J. C. LeVallé, and H. Chen. 1998. *Agricultural Market Performance and Determinants of Fertilizer Use in Ethiopia.* Grain Market Research Project Working Paper 10. Addis Ababa, Ethiopia: Ministry of Economic Development and Cooperation.

Dercon, S., and R.V. Hill. 2009. "Growth from Agriculture in Ethiopia: Identifying Key Constraints." Paper prepared as part of a study on agriculture and growth in Ethiopia for the United Kingdom Department for International Development (DfID). Oxford University, Oxford, UK. Accessed May 14, 2011. www.economics.ox.ac.uk/members/Stefan.Dercon/Ethiopia%20paper%203_v5.pdf.

Dercon, S., R. V. Hill, and A. Zeitlin. 2009. "In Search of a Strategy: Rethinking Agriculture-Led Growth in Ethiopia." Synthesis paper prepared as part of a study on agriculture and growth in Ethiopia for the United Kingdom Department for International Development (DfID). Oxford University, Oxford, UK. Accessed December 15, 2011. www.economics.ox.ac.uk/members/Stefan.Dercon/In%20Search%20of%20a%20Strategy_v3.pdf.

Dercon, S., D. O. Gilligan, J. Hoddinott, and T. Woldehanna. 2009. "The Impact of Agricultural Extension and Roads on Poverty and Consumption Growth in Fifteen Ethiopian Villages." *American Journal of Agricultural Economics* 91 (4): 1007–1021.

Dom, C., and M. Mussa. 2006a. *Review of Implementation of the Decentralisation Policy: A Sample Survey in Four Sentinel Woredas of Tigray Region*. Oxford, UK: Mokoro.

———. 2006b. *Review of Implementation of the Decentralisation Policy: A Sample Survey in Six Woredas of Amhara Region*. Oxford, UK: Mokoro.

Doss, C. R., W. Mwangi, H. Verkuijl, and H. De Groote. 2003. *Adoption of Maize and Wheat Technologies in Eastern Africa: A Synthesis of the Findings of 22 Case Studies.* Economics Working Paper 03-06. Mexico City: CIMMYT.

DSA (Development Studies Associates). 2006. *Study on Improving the Efficiency of Input Markets.* Addis Ababa, Ethiopia: Ministry of Agriculture and Rural Development.

EEA/EEPRI (Ethiopian Economic Association / Ethiopian Economic Policy Research Institute). 2006. *Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System* (PADETES). Addis Ababa, Ethiopia.

ERHS (Ethiopian Rural Household Survey). 2011. *Ethiopia Rural Household Survey Datasets: 2004 and 2009 Surveys.* Washington, DC: International Food Policy Research Institute. Accessed November 15, 2011. http://www.ifpri.org/dataset/ethiopian-rural-household-surveys-erhs.

ESE (Ethiopian Seed Enterprise). Various years. *Official Documents on ESE Seed Production.* Addis Ababa.

Ethiopia, CSA (Central Statistical Agency). Various years. *Statistical Abstracts and Statistical Bulletins.* Addis Ababa.

Ethiopia, MoARD (Ministry of Agriculture and Rural Development). Various years. *Official Documents and Records from the Agricultural Inputs Marketing Department and Crop Development Department.* Addis Ababa.

———. 2008. *A Plan to Fulfill Maize Seed Demand in the Next Five Years, 2008–09 to 2013–14*. (In Amharic). Addis Ababa.

———. 2009. *Official Documents and Records from the Agricultural Extension Directorate.* Addis Ababa.

FDRE (Federal Democratic Republic of Ethiopia). 1993. *An Economic Development Strategy for Ethiopia (A Comprehensive Guidance and A Development Strategy for the Future).* Addis Ababa, Ethiopia: Ministry of Planning and Economic Development.

———. 2002. *Ethiopia: Sustainable Development and Poverty Reduction Program.* Addis Ababa, Ethiopia: Ministry of Finance and Economic Development.

———. 2006. *Ethiopia: Building on Progress; A Plan for Accelerated and Sustained Development to End Poverty.* Addis Ababa, Ethiopia: Ministry of Finance and Economic Development.

Gebre-Egziabher, T., and K. Berhanu. 2007. "A Literature Review of Decentralization in Ethiopia." In *Decentralization in Ethiopia,* ed. T. Assefa and T. Gebre-Egziabher, 9–68. Addis Ababa, Ethiopia: Forum for Social Studies.

Gebremedhin, B., D. Hoekstra, and A. Tegegne. 2006. *Commercialization of Ethiopian Agriculture: Extension Service from Input Supplier to Knowledge Broker and Facilitator*. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project Working Paper 1. Nairobi, Kenya: International Livestock Research Institute.

Gerpacio, R. V. 2003. "The Roles of Public Sector versus Private Sector in R&D and Technology Generation: The Case of Maize in Asia." *Agricultural Economics* 29 (3): 319–330.

Gilligan, D. O., J. Hoddinott, and A. S. Taffesse. 2008. *The Impact of Ethiopia's Productive Safety Net Programme and Its Linkages*. IFPRI Discussion Paper 839. Washington, DC: International Food Policy Research Institute.

Harrigan, J. 2008. "Food Insecurity, Poverty, and the Malawian Starter Pack: Fresh Start or False Start?" *Food Policy* 33 (3): 237–249.

Hassan, R. M., M. Mekuria, and W. Mwangi. 2001. *Maize Breeding Research in Eastern and Southern Africa: Current Status and Impacts of Past Investments Made by the Public and Private Sectors, 1966–97.* Mexico City: CIMMYT.

Howard, J., E. Crawford, V. Kelly, M. Demeke, and J. J. Jeje. 2003. "Promoting High-Input Maize Technologies in Africa: The Sasakawa-Global 2000 Experience in Ethiopia and Mozambique." *Food Policy* 28 (4): 335–348.

Ibrahim, M. 2004. "Extension Experiences in Ethiopia." Paper presented at the Ministry of Agriculture and Rural Development Planning Workshop. Addis Ababa, Ethiopia: Ministry of Agriculture and Rural Development.

IFPRI (International Food Policy Research Institute). 2009. *A Study in Support of the Mars-Food Action of the European Union: The Cereal Availability in Ethiopia, 2007/08.* Final Technical Report of the Project submitted to the European Commission Joint Research Centre. Fermi, Italy: Institute for the Protection and the Security of the Citizen.

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

Keeley, J., and I. Scoones. 2000. "Knowledge, Power, and Politics: The Environmental Policy-Making Process in Ethiopia." *Journal of Modern African Studies* 38 (1): 89–120.

Kotu, B. H., H. Verkuijl, W. Mwangi, and D. Tanner. 2000. *Adoption of Improved Wheat Technologies in Adaba and Dodola Woredas of the Bale Highlands.* Addis Ababa, Ethiopia and Mexico City: Ethiopian Agricultural Research Organization and CIMMYT.

Langyintuo, A. S., W. Mwangi, A. O. Diallo, J. MacRobert, J. Dixon, and M. Bänziger. 2008. *An Analysis of the Bottlenecks Affecting the Production and Deployment of Maize Seed in Eastern and Southern Africa.* Harare, Zimbabwe: CIMMYT.

Lantican, M. A., H. J. Dubin, and M. L. Morris. 2005. *Impacts of International Wheat Breeding Research in the Developing World, 1988–2002.* Mexico City: CIMMYT.

Minot, N. 2009. *Market Dynamics and Cereal Availability in Ethiopia: Producers, Traders, and the Policies.* Agricultural Household Survey. Understanding Changes in Farm-Level Crop Marketing Policy Brief 1. Addis Ababa, Ethiopia: Ethiopian Development Research Institute and International Food Policy Research Institute.

Mishra, D. 2008. "Ongoing Policy Debate on the Causes and Remedies of Ethiopia's High Inflation." Paper presented as part of the Africa Chief Economist Seminar Series. Washington, DC: World Bank.

Morris, M. L., ed. 1998. *Maize Seed Industries in Developing Countries.* Boulder, CO, US: Lynne Rienner.

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

Pausewang, S., K. Tronvoll, and L. Aalen, eds. 2003. *Ethiopia since the Derg: A Decade of Democratic Pretension and Performance*. London: Zed.

Pray, C. E. 1992. "Plant Breeders' Rights Legislation, Enforcement and R&D: Lessons for Developing Countries." In *Sustainable Agricultural Development: The Role of International Cooperation*, ed. G. Peters and B. Stanton. Proceedings of the Twenty-First International Conference of Agricultural Economists, August 22–29, 1991, in Tokyo. Brookfield, VT, US: Dartmouth.

Pray, C. E., B. Ramaswami, and T. Kelley. 2001. "The Impact of Economic Reforms on R&D by the Indian Seed Industry." *Food Policy* 26 (6): 587–598.

Rahmato, D. 2004. "The Agricultural Policies of the Imperial Regime: What Lessons Can We Draw?" Paper presented on the occasion of the 50th anniversary of the establishment of Alemaya University, October 23–24, in Alemaya, Ethiopia.

Sahlu, Y., and M. Kahsay. 2002. "Maize Seed Production and Distribution in Ethiopia." In *Proceedings of the Second National Maize Workshop*, November 12–16, 2001, in Addis Ababa, Ethiopia.

Segers, K., J. Dessein, S. Hagberg, P. Develtere, M. Haile, and J. Deckers. 2008. "Be Like Bees: The Politics of Mobilizing Farmers for Development in Tigray, Ethiopia." *African Affairs* 108 (430): 91–109.

Spielman, D. J., M. J. Cohen, and T. Mogues. 2009. "Local Governance Systems and

Smallholder Cooperatives in Ethiopia." *International Journal of Agricultural Resources, Governance, and Ecology* 8 (5–6): 388–408.

Stepanek, J. C. 1999. "Lessons from Ethiopia's High-Input Technology Promotion Program: How the Organization of the Fertilizer Subsector Affects Maize Productivity." PhD dissertation, Department of Agricultural Economics, Michigan State University, East Lansing, MI, US.

Taffesse, A. S. 2008. "Decomposition of Growth in Cereal Production in Ethiopia." International Food Policy Research Institute, Addis Ababa, Ethiopia. Mimeo.

Thijssen, M. H., Z. Bishaw, A. Beshir, and W. S. de Boef, eds. 2008. *Farmers, Seeds, and Varieties: Supporting Informal Seed Supply in Ethiopia.* Wageningen, the Netherlands: Wageningen International.

Tripp, R., and N. Louwaars. 1997. "Seed Regulation: Choices on the Road to Reform." *Food Policy* 22 (5): 433–446.

Ulimwengu, J. M., S. Workneh, and Z. Paulos. 2009. *Impact of Soaring Food Price in Ethiopia: Does Location Matter?* IFPRI Discussion Paper 00846. Washington, DC: International Food Policy Research Institute.

Vaughan, S., and K. Tronvoll. 2003. *The Culture of Power in Contemporary Ethiopian Political Life*. Swedish International Development Cooperation Agency (SIDA) Studies 10. Stockholm, Sweden: SIDA.

World Bank. 2005. *Ethiopia—Well-being and Poverty in Ethiopia: The Role of Agriculture and Agency.* Report 29468–ET. Washington, DC: World Bank.

———. 2006a. *Promoting Fertilizer Use in Africa: Lessons Learned and Good Practice.* Africa Region paper. Washington, DC.

———. 2006b. "World Bank Support to the Ethiopian Seed Sector." World Bank, Addis Ababa, Ethiopia. Mimeo.

Wubneh, F. K. 2007. *Realizing the Dream: Agricultural Extension for Rural Livelihoods Development in Ethiopia.* The Hague, the Netherlands: Institute of Social Studies Graduate School of Development Studies.

Zegeye, T. 2001. *The Impact of Technology Development and Transfer: The Case of Maize in Ethiopia.* Ethiopian Agricultural Research Organization (EARO) Research Report 42. Addis Ababa, Ethiopia: EARO.

Zegeye, T., and A. Haileye. 2001. *Adoption of Improved Maize Technologies and Inorganic Fertilizer in North-western Ethiopia.* Ethiopian Agricultural Research Organization (EARO) Research Report 40. Addis Ababa, Ethiopia: EARO.

Zegeye, T., B. Tadesse, and S. Tesfaye. 2001a. *Adoption of High Yield Maize Technologies in Major Maize Growing Regions of Ethiopia.* Ethiopian Agricultural Research Organization (EARO) Research Report 41. Addis Ababa, Ethiopia: EARO.

———. 2001b. *Determinants of High Yielding Maize Technology Adoption: Empirical Evidence.* Ethiopian Agricultural Research Organization (EARO) Research Report 38. Addis Ababa, Ethiopia: EARO.

Zegeye, T., G. Taye, D. Tanner, H. Verkuijl, A. Agidie, and W. Mwangi. 2001. *Adoption of Improved Bread Wheat Varieties and Inorganic Fertilizer by Small-Scale Farmers in Yelmana Densa and Farta Districts of Northwestern Ethiopia.* Addis Ababa, Ethiopia and Mexico City: Ethiopian Agricultural Research Organization and CIMMYT.