Africa has entered a phase of rapid commercialization of its food and agricultural system that provides major new opportunities for privately conducted research and development (R&D). Indeed, unless both public and private investment in agricultural R&D is stepped up sharply, lack of competitiveness will prevent Africa from seizing these opportunities. Rapid growth of domestic and regional markets offers the most attractive opportunities for African commercial agriculture. Assuming that Africa meets a 6 percent growth rate (which many countries are already doing), rising consumer incomes and the projected doubling of the urban population in Africa by 2030 imply that urban food markets will quadruple in the next 20 years (World Bank 2013).

Rising market opportunities can be met by domestic production or by food imports. Given its substantial land and water resources, Africa has a comparative advantage in most food products (with important exceptions, such as wheat). Nevertheless, food import shares have been rising in recent years, such that Africa has converted from a significant net agricultural exporter in the 1970s, to a significant net agricultural importer in the 2000s, reflecting poor competitiveness in many products, such as rice—the fastest-growing import.

Similarly, opportunities are provided by booming export markets where world agricultural trade approximately tripled in nominal value terms from 1993 to 2008. Middle-income developing countries successfully captured the bulk of this market growth (with Brazil, Argentina, Indonesia, Thailand, and Malaysia occupying five of the top six places), but African countries have...
ranked very poorly. While Africa contributes 12.1 percent of world population and 5.3 percent of agricultural gross domestic product (AgGDP), its share of global agricultural exports fell to 2.0 percent in 2009, compared with 7.6 percent in the early 1960s.

Declining competitiveness is in large part due to low and stagnant productivity. Fuglie and Rada (Chapter 3, this volume) indicate that although total factor productivity (TFP) growth in Africa south of the Sahara (SSA) has reversed its negative trend since the mid-1980s, it is still increasing at only half of the rate of developing countries as a whole. They attribute poor productivity performance to low and stagnating investment in R&D, along with poor macroeconomic policy up to 1990. Although Fuglie and Rada (this volume) only analyzed public-sector R&D and CGIAR investments, the lack of private-sector research is also likely to be a factor undermining Africa’s performance. As one example, Africa was the leading producer of oil palm up to 1975, a crop that originated in Africa; however, in the 1960s, Malaysia mounted a strong industry-led effort to fund and conduct R&D on oil palm, which quickly made the country the world’s leading palm oil exporter. Much of this research spilled over to Indonesia, and exports of palm oil by these two countries now exceed the value of all agricultural exports from SSA.

Today, with a more conducive policy environment, commercial agriculture could be a major source of growth in many SSA countries, following the recent path of Brazil, Thailand, and other emerging economies over the past 20 years. The challenge is to invest more in R&D to ensure that African countries can compete in growing markets. Already, a more open policy environment in the 2000s is stimulating strong private investor interest in Africa that could spur private R&D. Agriculture and associated industries are now among the favored sectors for foreign direct investments to the tune of about US$1 billion in 2007 (Miller et al. 2010).

The potential for growth in R&D by private firms and industry associations in Africa is great. Research by private input firms outside of South Africa is just getting started and is still limited to maize, some vegetables, and export crops. Applied research in some large food-processing firms in beer, horticulture, and sugar, as well as research by industry associations funded by levies on export crops, was started in the colonial period. Private research, however, remains constrained by small markets, weak public-sector research programs, a shortage of scientists and technicians, and a difficult business environment, including competition with government corporations and weak intellectual property rights (IPR). Levy-funded industry associations lack
internal support for greater funding and government incentives to increase private R&D funding.

This chapter provides an overview of private agricultural R&D in SSA. The approach is not comprehensive, but is analyzed through a series of case studies. The next section provides an overview of three types of private agricultural R&D and their main drivers as a preamble to a more detailed case study review centered on the typology. Thereafter, the discussion focuses on policies needed to realize the potential of private African agricultural R&D into the future, before providing final conclusions.

Types of Private Agricultural R&D

It is well known that the private sector underinvests in research, in large part because of the nonexclusive and nonrival nature of the products of research (Ruttan 2001). In some cases, such as hybrid seed, profits from specialized private input firms that carry out R&D can be appropriated, although these are infrequent in the African context and are mainly confined to hybrid maize. Stronger IPR could assist in overcoming this barrier. A less stated reason for private underinvestment is that much research involves significant economies of size resulting from high fixed costs relative to market size. In agriculture—outside of a few cases, such as plantation crops and commercial horticulture—farms and other firms in the industry are generally too small to efficiently undertake R&D for their own use beyond very simple adaptive research for testing new technologies.

Private agricultural research is generally funded by three groups of industries: agricultural input industries, production agriculture, and the agricultural processing industry. These firms may finance and conduct their research in-house, outsource research to research organizations or universities, or finance research collectively with other firms. In Africa, the three main combinations of industry and research organizations are in-house research conducted by input firms, in-house research conducted by large plantations or agricultural processing firms, and collective research undertaken by producers and processors. Each of these is discussed below in turn.

Intramural R&D by Agricultural Input Industries

Agricultural input firms invest in research to develop new inputs that will increase the productivity of farmers or increase the quality of agricultural output. Input firms profit by increasing their sales to farmers. The firms must decide whether to invest in agricultural R&D based on its cost, the
probability of its success, the size of the potential market for the improved input, the cost of producing and marketing the improved input, and the firms’ ability to keep it from being copied by competitors. Moreover, the decision to conduct R&D has to be weighed against options to license public or private technology from within or outside the country.

Research to develop new chemicals, new biotech traits, and new tractors can require large investments in experiment stations, laboratories, computers, and engineering facilities, as well as large numbers of well-qualified scientists, engineers, and technicians. Often only a few multinational companies make sufficient turnover worldwide to fund the research that generates these new technologies. Monsanto, for example, invests more than US$1.5 billion per year in R&D (Monsanto 2013). Some types of applied research, however—such as plant breeding or engineering new agricultural implements—do not require such massive investments. This is particularly the case when African firms can build on research conducted by government institutes, universities, or international agricultural research centers. An important factor that drives up private firms’ research costs in Africa and reduces the probability that research will be successful is the shortage of scientists and weak public-sector research in many countries.

In small countries, of which Africa has many, the small size of both the agricultural sector—in terms of AgGDP—and of modern input markets significantly limits opportunities for private firms to profit from investing in agricultural research. The level of adoption of improved inputs in SSA is far below other regions of the world. For example, the 2008 World Development Report showed that the adoption of improved crop varieties in Africa in 2000–2005 was considerably lower than in Asia and Latin America for all major staple crops except cassava (Walker et al. 2014). Government policies that tax agriculture rather than staying neutral or subsidizing it are in part to blame for holding back the demand for modern inputs in many African countries. The nominal rate of assistance to agriculture shows that Senegal, Tanzania, and Zambia taxed agriculture in the period 2000–2004, and that South Africa was neutral. Only Kenya subsidized agriculture (Anderson and Valenzuela 2008). Another factor that, until recently, limited the incentive for African firms to invest in modern inputs was the large role that parastatal corporations played in the provision of inputs. In the seed sector, Tanzania had the parastatal Tanseeds, Zambia had Zamseeds, and Kenya had the Kenya Seed Company (KSC). Only South Africa had a fully privatized seed production industry before 2000.

The ability of agricultural input firms to capture some of the economic surplus created by new technologies they develop may also be limited by weak
IPR. Park’s (2008) index of the strength of IPR ranges from 0 to 5. With a score of 4.25, South Africa has the strongest IPR of the sample countries; scores for the other African countries in the study range from 1.94 to 3.22. In some cases, firms can protect their investments in innovation by offering technologies that are difficult to copy for technical reasons and, hence, preserve trade secrets (such as hybrid cultivars whose parentage is not divulged, or pesticides produced using complicated chemistry).

**Intramural R&D Undertaken by Large Plantation or Processing Companies**

Agricultural processing and plantation firms invest in research and innovation to reduce their production costs or improve the quality of the agricultural products they produce or purchase. Like input firms, they will have to make substantial investments in experimental fields, laboratories, and scientists, and compare the costs for research with the costs and effectiveness of importing technologies.

For plantations, the profits from these investments in R&D or imported technologies depend on the size of the plantation and how much the innovation reduces the cost of production or increases the market value of their commodity. If the innovation quickly spreads to competing firms and pushes down commodity prices, the R&D investment will yield little profit. Only a few plantation companies, such as those producing pineapples in Kenya and tea in several East African countries, are big enough to fund their own research.

For agricultural processing firms, the returns to R&D investments are a function of the degree to which agricultural costs can be reduced, based on reduced prices for commodities purchased combined with the quantity of products purchased—both of which can be strengthened by monopsonistic power in the commodity market. Some sugar mills in Africa own large sugarcane plantations or have sufficient market power to profit from investing in their own sugarcane research. Their returns depend on the degree to which the research can reduce production costs, while maintaining quality. Tobacco

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1 Note that these industries are involved in research targeting agricultural production and agricultural processing. However, in the context of this discussion, the focus is on research related to agricultural production. Processing and plantation firms are interested in having a steady supply of good-quality agricultural produce at low prices. For these firms to invest in research on agricultural production, the market structure of the processing industry needs to be monopolistic or oligopolistic.
processors in several countries invest in tobacco research to keep the costs of tobacco production down and improve quality.

When individual plantation and processing firms need to solve key problems but are not large enough to afford their own research infrastructure, they often contract with public-sector providers to conduct targeted research, for example, on specific diseases or pests or breeding-related issues. Alternatively, they may organize the industry to support levy-based R&D (described below). Like input industries, private plantation and processing industries have been limited by government policies and ownership. Parastatals in the processing industry and marketing boards for export commodities limited the role of the private sector. The sugar industry, for example, was controlled by parastatals in Senegal and Tanzania up until 1995 and 1998, respectively. Cotton processing and exports and groundnut oil production and exports were also government owned in Senegal until the mid-2000s. Privatization and breaking up processing-industry monopolies does not necessarily lead to more research, however, because the new companies may have less ability to capture the gains from their research: their markets may be smaller, and they may lose their ability to extract gains from research that cuts agricultural production costs.

**Levy-Based R&D Undertaken through Collective Action by Agricultural Producers and Processors**

This type of private R&D is almost always backed by legislation to impose a small tax—commonly known as a “levy” or “cess”—on production in order to fund collective goods or services that are in turn made accountable to industry representatives. This funding arrangement has two major objectives. First, and most obviously, it aims to increase the total funding of R&D in a specific industry (Bingen and Brinkerhoff 2000), given the overwhelming evidence of underfunding of R&D nearly everywhere. Second, if constructed as truly collective action by users rather than a dictate by government, it aims to empower users in setting the research agenda and making research organizations accountable to them (Klerkx and Leeuwis 2008).

Given potential incentives for free riders, this kind of collective action depends on the industry being able to make the cost of research mandatory for all firms, which in turn requires a sufficient number of firms acting through the political process to make the case for the necessary legislation. In a diverse industry with firms of different sizes, R&D costs can be shared according to a measure of size to achieve some level of equity. A common way to do this is to set a levy as a share of production value. In addition, agriculture is agro-climatically and structurally diverse, so some farms will inevitably gain more,
and some may even lose from technological change. These disparities are fur-
ther accentuated if larger and more politically powerful members have dispro-
portionate influence in a collective process to set the research agenda. At the
extreme, very large firms able to efficiently conduct their own R&D may have
little incentive to join in collective action on R&D.

Beyond these conceptual issues, a number of practical issues have also
been identified with using levies to fund research (for example, Brennan and
Mullen 2003; Kangasniemi 2003). The most obvious limitations are the fea-
sibility and cost of collecting levies in smallholder agriculture. In general, col-
lecting levies is only cost-effective for commercial crop and livestock products
that pass through a small number of processing or marketing points. This is
obvious for most export-oriented products, but many opportunities also exist
within domestic markets, especially where production is largely commercial
and geographically concentrated. Examples in Africa include irrigated rice,
wheat, and sugarcane and, in many cases, some partly commercial products,
such as groundnuts, poultry, and dairy.

There are also practical issues related to the objective of making R&D
more accountable to industry in terms of priorities and delivering results.
Levies therefore require strong industry governance and accountability mech-
nanisms, with appropriate means to aggregate demand from different segments
of the industry and from different geographical subregions. An additional
complication is that the case for collective action goes beyond R&D to include
other industry-related public goods or services, such as market promotion,
extension, and control of pests. Clearly, efficiencies exist in having one levy
cover a variety of activities, but the allocation of the funds among research and
other uses becomes a further decision point. Long-term risky activities, such
as R&D, are likely to be penalized in this process (as are R&D expenditures in
public budgets).

Finally, there are a variety of institutional design issues for undertaking
the research generated by such funds. Funds may be managed by a dedicated
funding body (common in Australia) that outsources research competitively
or through other means to existing, largely public, research organizations.
In other cases, a dedicated commodity research institute under the control
of the industry is funded through the levy, although this may reduce econo-
 mies of size and scope. A levy may also be applied across commodity subsec-
tors, with a single governing body that either outsources research (for example,
Côte d’Ivoire) or funds a multicommodity research institute (for example,
Uruguay). This complicates governance, because allocation across subsectors
is a further decision point.
Evidence of Private Intramural R&D by Input Firms, Plantations, and Processing Firms

The evidence presented in this section was collected through a series of case studies in five African countries: Kenya, Senegal, South Africa, Tanzania, and Zambia. Collaborative research teams, including scientists or economists from each country and collaborators from the International Food Policy Research Institute, McGill University, and Rutgers University, conducted country studies during 2009–2011 involving a survey on innovations, research expenditures, and personnel from a sample of private organizations from all segments of agribusiness.2

Private research in SSA, in terms of expenditures and the number of scientists, is limited. For the five study countries, total 2008 expenditures on agricultural R&D were at least $75 million purchasing power parity (PPP) dollars (in 2005 prices), and 331 scientists were privately employed (Table 7.1). The survey data, however, do not capture all of the private research undertaken, because a number of firms known to conduct R&D either did not respond or responded without providing expenditure data. As a result, country teams estimated actual private R&D expenditure in 2008 to be about $100 million based on their knowledge of the firms that did not provide R&D data (last row of Table 7.1).

In 2008 South Africa accounted for 72–78 percent percent of private agricultural R&D expenditures in the sample (Table 7.1). R&D related to the seed industry was the largest component, followed by research on sugarcane and citrus fruit, which is performed by private organizations paid for by these industries. Senegal had the next-largest private R&D expenditures and number of scientists. Much of Senegal’s private research is by recently privatized corporations processing groundnuts and cotton, and a sugar mill that conducts research on sugarcane, sugar milling, and biofuels. Kenya recorded the third-highest private R&D expenditures in 2008. A number of companies in Kenya invest in plant breeding, and a few invest in R&D for fertilizers and processing. Whereas private sugar mills and tea and coffee plantations in some other African countries conduct research for these commercial crops, in Kenya, research on these commodities is conducted by parastatal or nonprofit institutes, and is paid for by a combination of funds derived through commodity levies (discussed further later in this chapter) and from government contributions. Tanzania had the next-highest R&D expenditures, with research concentrated in seed and sugar. In the study sample, private firms in

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2 Private agribusiness was defined to include agricultural input firms, farms and plantations, and industries that process agricultural products and that were at least 51 percent privately owned. Research foundations and trusts funded through commodity taxes and managed by the government were excluded.
### Table 7.1: Private R&D, research staff, and research budgets in study countries, 2008

<table>
<thead>
<tr>
<th>Industry</th>
<th>South Africa</th>
<th>Kenya</th>
<th>Senegal</th>
<th>Tanzania</th>
<th>Zambia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>95</td>
<td>27,143</td>
<td>8</td>
<td>1,600</td>
<td>19</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>2</td>
<td>NR</td>
<td>3</td>
<td>NR</td>
<td>7</td>
</tr>
<tr>
<td>Pesticide</td>
<td>6</td>
<td>4,286</td>
<td>5</td>
<td>NR</td>
<td>2</td>
</tr>
<tr>
<td>Machinery</td>
<td></td>
<td></td>
<td>1</td>
<td>NR</td>
<td>1</td>
</tr>
<tr>
<td>Livestock and fisheries inputs</td>
<td>9</td>
<td>2,857</td>
<td>0</td>
<td>NR</td>
<td>5</td>
</tr>
<tr>
<td>Plantation processing</td>
<td></td>
<td></td>
<td>9</td>
<td>NR</td>
<td>4</td>
</tr>
<tr>
<td>Crop</td>
<td>91</td>
<td>22,857</td>
<td>2</td>
<td>NR</td>
<td>5</td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total for surveyed organizations</td>
<td>201</td>
<td>58,571</td>
<td>12</td>
<td>4,000</td>
<td>61</td>
</tr>
<tr>
<td>Estimated actual total</td>
<td>71,429</td>
<td>8,000</td>
<td>9,400</td>
<td>6,000</td>
<td>6,000</td>
</tr>
</tbody>
</table>

**Source:** Pray, Gisselquist, and Nagarajan (2011).

**Note:** NR indicates that data are not reported to protect the organizations’ confidentiality, given that only one company in each of these categories reported research. Data on researchers are for individuals, not full-time equivalents; some organizations reported that research staff may also have part-time nonresearch duties. The estimated actual data for South Africa (the last row of the table) include estimates of private research spending by companies that were not contacted or that did not return questionnaires. For example, in the case of South Africa, major research programs, such as Pioneer, Illovo Sugar, Sappi Limited, and Mondi, did not respond to the questionnaire, so as much as an estimated 20 percent of the country’s private research could have been omitted. Also, as much as half the country’s private research could have been omitted based on lack of data for Del Monte and floriculture firms, such as Oserian. Similarly, as much as half of Kenya’s private research, primarily on commercial crops like tobacco and sugarcane, could have been omitted. PPP = purchasing power parity.
Zambia spent the least on R&D, although the country employs more private scientists than Kenya.

The two industries that attracted the most R&D investment are the seed and processing industries, a pattern that is common across all five case study countries (Table 7.1). Research on livestock inputs and pesticides (primarily tri- als for registration) is important in South Africa, Senegal, and Zambia. Research on sugarcane is important in Senegal, South Africa, and Zambia, as is research on tea and coffee in Tanzania. At 0.6 percent, South Africa’s research intensity (private agricultural R&D expenditure as a share of AgGDP) is the highest among the study countries, followed by Senegal (Table 7.2). Zambia has higher research intensity than Kenya and Tanzania, but this is partly because it has a small agricultural sector. Kenya and Tanzania, which have small R&D expenditures and large agricultural sectors, recorded the lowest R&D intensities of the study countries. Bangladesh and India, which were studied at the same time, are included for comparison. They have research intensity levels below South Africa, but about the same as the other African countries.

About half of the research recorded in the 2008 survey was conducted by African firms, some of which are regional multinational corporations. The other half of the R&D was conducted by multinational corporations head-quartered in Europe and the United States. In South Africa, US–based firms conducted about half the seed and biotech research and most of the pesticide research; other research is conducted by South Africa–based firms, some of which are themselves multinational corporations—for example, Pannar (seeds), Illovo Sugar, and South Africa Breweries.3 In Kenya, both local com-

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3 Pannar was purchased by DuPont in 2013 and is gradually being integrated into the DuPont Pioneer subsidiary; 51 percent of Illovo was purchased by Associated British Foods in 2006, but it continues to have its headquarters in South Africa and is listed on the Johannesburg Stock Exchange.
panies (such as East African Seed and Western Seed) and Africa-based mult-

inational corporations (such as Pannar and Zimbabwe’s Seed Co), as well as
Pioneer and Monsanto, have small maize-breeding programs. Multinational
corporations are also active in research on tobacco, pineapples, sugarcane, and
tea in East Africa. In Senegal the major groundnut, cotton, sugarcane, and
horticulture firms that conduct much of the private research are now con-
trolled by French or Swiss firms (Stads and Sène 2011).

The Senegal, South Africa, and Zambia studies contained data on pri-
grew by 22 percent in constant US dollars. Eighty percent of the growth was
accounted for by seed companies and some smaller companies that are both
seed and fertilizer businesses (Kirsten, Stander, and Haankuku 2011). In
Senegal, R&D expenditures rose by 40 percent during the same period; all of
the increase was accounted for by vegetable seed or vegetable and fruit pro-
cessing firms (Stads and Sène 2011). In Zambia, the number of scientists who
worked at least part time on research grew by 56 percent during 2001–20084;4
most of this growth was in the processing industry, followed by the seed
industry (Mwala and Gisselquist 2012). The interviews conducted in the five
countries indicated that plant breeding also grew in Kenya and Tanzania. In
Kenya, livestock-related research grew, but data on other industries in Kenya
and Tanzania are insufficient to indicate whether private research actually
increased in the aggregate during 2001–2008.

The Seed Industry

Maize dominates the seed market in East Africa and Southern Africa. Recent
studies of the East Africa market showed that 87 percent of seed sales in
Kenya, 71 percent in Tanzania, and 75 percent in Uganda were maize seed
sales (Erenstein, Kassie, and Mwangi 2011), whereas vegetables were a small
but growing component of the market. Maize is not as important in West
Africa, particularly in Senegal, where vegetables constitute a much larger share
of the commercial seed market. As of 2007, global multinational companies
accounted for 18 percent of maize sales in SSA, whereas regional multination-
als, such as Pannar and Seed Co, accounted for 46 percent, and national com-
panies accounted for 36 percent (Langyintuo et al. 2010).

Growth in privately performed R&D in the seed industry developed in
response to the liberalization and subsequent growth of the seed industry in

4 More companies reported scientists than R&D trends, so researcher numbers are considered a
more accurate indicator of trends (Mwala and Gisselquist 2012).
all study countries, ending government monopolies on the sale of improved seed in combination with varying degrees of privatization. The seed industries of Tanzania and Zambia followed the path of first allowing competition and then privatizing the government seed companies, Zamseed and Tanseed, in the 1990s. Cargill was the first private company to register a maize hybrid in Tanzania, followed by Pannar, Monsanto, and Pioneer later in the decade. In Zambia, Pioneer was the first company to bring in maize hybrids in 1992; other private companies registering one or more maize hybrids in the 1990s included Carnia (from South Africa), Cargill, Pannar, Seed Co, and the local company Maize Research Institute.

Like Zambia and Tanzania, Kenya allowed competition in the 1990s, but unlike those countries, it did not privatize its seed parastatal, KSC. KSC, which produced seed of the Kenya Agricultural Research Institute’s (KARI’s) new cultivars, had a monopoly on the distribution of certified maize seed until 1993. A key change allowing private companies to enter the market was a new willingness on the part of seed regulators to register cultivars from private companies. A number of small Kenyan companies, such as Western Seed Company and East Africa Seed Co., entered or expanded their seed business in the 1990s. Pannar and Cargill also entered the seed business in that period. Monsanto entered the Kenyan market by buying Cargill’s international seed business, and then registering its first maize hybrids in Kenya in 2000. Seed Co’s first maize hybrid was approved for sale in 2003. In 2003–2004, however, KSC still accounted for 86.5 percent of the total volume of maize seed produced by the formal seed industry in Kenya, according to Ministry of Agriculture estimates (Odame, Kangai, and Spielman 2012). The partial opening of seed markets in East Africa to maize hybrids from other countries and to seed imports has allowed national, regional, and other multinational seed companies to develop and introduce new cultivars, focusing on crops for which seed markets are large (especially in terms of hybrid maize) and for which the introduction of new cultivars is unregulated (vegetables and forage crops in Kenya and Zambia).5

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5 Zimbabwe’s Seed Co is a useful example. It began in 1940 as a private farmers’ cooperative producing maize seed; in 1973 the cooperative purchased a breeding station; and in 1996 it was re-registered as a publicly owned company selling shares on the Zimbabwe Stock Exchange. Seed Co has developed into a regional multinational, expanding into Ethiopia, Kenya, Malawi, Zimbabwe, and other countries as their markets opened. As the business climate in Zimbabwe deteriorated after 2000, Seed Co moved some of its research to Zambia. The company also has a technology agreement with Syngenta that provides Seed Co with access to Syngenta’s technologies from elsewhere in the world, and Syngenta with access to Seed Co’s white maize hybrids and soybean lines. Recently, the French company Limagrain purchased 25 percent of Seed Co’s shares, which will help Seed Co expand its operations in Zambia and Malawi (Mapakame 2013).
Maize research has also increased because of the growth in maize production, which increased in response to the quantity of the maize seed sown. Data on maize seed use from the Food and Agriculture Organization of the United Nations show that in East Africa, maize seed increased from about 300,000 tons in 2000 to 400,000 tons in 2011. Seed use in West Africa (primarily Nigeria) also increased rapidly. The only subregion where maize seed use declined was Southern Africa, which includes South Africa and Zimbabwe. Further driving R&D on maize, most of the maize sold is hybrid maize, giving developers the ability to capture a substantial part of the benefits from new hybrids, as they must be purchased every year to maintain their yield performance.

South Africa’s seed industry research dwarfs research in the other sample countries (more than $19 million in seed and biotech R&D in 2008, compared with less than $2 million for the other four countries combined). The size of the market for innovation in maize and soybeans in South Africa increased dramatically during 2001–2008 because of the spread of genetically modified (GM) maize from 57,000 hectares in 2000/01 to 1.89 million hectares in 2009/10 (Gouse 2013). Even in 2001, almost all of the maize seed was high-quality hybrids that companies sold at high prices. Adding GM insect resistance and herbicide tolerance allowed firms to charge a technology fee on top of the hybrid price. Demand for conventional hybrids from South Africa also increased as markets in Southern and East Africa opened up, but where the release of GM seeds has not been approved. IPR on new plant varieties, hybrids, and transgenic traits are as strong in South Africa as they are in the United States. With the end of apartheid, foreign firms brought in new capital to establish subsidiaries, purchase local seed companies, and finance research.

The investments in seed industry research in South Africa were encouraged by several other factors. The dominance of large commercial farms that regularly purchase the latest variety or hybrid has provided a ready market for companies. The availability of scientists in South Africa was greater than other African countries because of a relatively large public agricultural research system and a strong agricultural university system. South Africa is also a comparatively comfortable place for foreign scientists to live, so private firms can attract scientists from elsewhere in Africa and the rest of the world. Strong human resource capacity and IPR, together with an efficient biosafety regulatory system, allow the private and the public sectors to use the latest biotechnology research tools and GM traits to produce improved crop varieties faster. South Africa’s capacity to use biotechnology has been helped by biotechnology research funded by the Rockefeller Foundation, the Bill &
Melinda Gates Foundation, and the United States Agency for International Development.

**The Plantation and Processing Industries**

The basis for private research by firms in the agricultural processing industry in Africa was also the elimination of government monopolies and the privatization of government processing industries. The impact of nationalization and later liberalization on private technology transfer and research varies considerably among countries, products, and time periods. After 2000, Senegal privatized the companies that controlled the processing of two major cash crops: cotton and groundnuts. The government sold 51 percent of SODEFITEX, the cotton monopoly, to a French company in 2003. And Suneor, the government groundnut processing company, was privatized in 2005. Both of these companies had their own research programs before privatization; the privatization of these programs led to much of the growth in private research in Senegal (although not necessarily to more R&D for the country in total).

In East Africa, nationalization followed by liberalization and privatization had mixed impacts on R&D in the plantation and processing subsectors. During colonial times, research on plantation crops—such as coffee and tea in Kenya and Tanzania, sugarcane in Kenya, and such cash crops as cotton in Zambia—was originally financed by commodity levies. Independent governments nationalized some of the monopolies and extended government control over formerly autonomous research institutes. In Kenya in the 1970s, monopolists controlled pineapple processing and plantations (Del Monte), barley (Kenya Breweries Ltd.), and tobacco (BAT Kenya Ltd.), paying for and managing research on these crops. Liberalization did not affect the pineapple monopoly, but South African Breweries entered the beer industry in 1998, and a local company, Mastermind Tobacco, and another multinational, R. J. Reynolds, entered the tobacco industry. A study by Ndii and Byerlee in 2004 suggested that private research on plantation crops and processing in Kenya declined with increased competition after liberalization.

The end of apartheid in South Africa and liberalization of trade and regulations on foreign investment in the rest of Africa have encouraged South African firms to expand into African regional markets. An important example of the impact of liberalization on agricultural research is Illovo Sugar. Its expansion outside South Africa began in 1996, when it bought 50 percent of a Mozambique sugar mill. In 1997, it bought Lonrho Sugar Corporation, which had sugar mills and land in Malawi, Mauritius, South
Africa, and Swaziland. In 1998, Illovo bought 55 percent of the Tanzanian government’s sugar company at Kilombero, and in 2001 it bought the Zambian sugar company that had been a parastatal. Illovo Sugar is now Africa’s biggest sugar producer. In 2009/10, the estates it managed produced 6.1 million tons of cane, while contract growers supplied about 8 million tons of cane. About 40 percent of its production is in South Africa. Illovo Sugar accounts for 32 percent of sugar production in Mozambique, 30 percent in South Africa, 35 percent in Swaziland, 46 percent in Tanzania, and 94 percent in Zambia (Illovo Sugar 2011). In 2011, the firm spent $3.5 million on research for all of its African operations, most of which was spent in South Africa (Illovo Sugar 2011).

While privatization and liberalization of rules on foreign investment made the expansion of these companies possible, demand for sugar is what made the investments in expansion into new countries profitable. In turn, this demand provided the incentive to invest in importing technology, such as sugarcane varieties from Mauritius and South Africa, and in the adaptive research that was required to make those technologies productive. International demand for sugar from such countries as India has expanded rapidly in recent years. Preferential trade agreements offered by the European Union to low-income countries have helped some African countries to improve their position in supplying European demand for sugar.

**Commodity Levies to Fund R&D**

**The Current Use of Levies and Their Potential**

Agricultural Science and Technology Indicators (ASTI) data and reports provide an overview of current use of commodity levies (or cesses). A very rough overall estimate indicates that, in 2008, about $93 million in 2005 PPP dollars, or about $45 million in 2005 US dollars at official exchange rates, was provided by industry for research in SSA, most commonly for coffee, cocoa, tea, sugar, and tobacco (Table 7.3). This amounted to less than 6 percent of total agricultural R&D spending. Only 9 of 26 ASTI countries appear to use any levy, and where they do, only a couple of commodities are covered. Additionally, more than half of these funds were generated in just two countries: Ghana for cocoa (33 million 2005 PPP dollars) and South Africa for sugar (19 million 2005 PPP dollars) (Nieuwoudt and Nieuwoudt 2004). Côte d’Ivoire, Kenya, Malawi, Mauritius, and Tanzania each generated 5–10 million 2005 PPP dollars in levies.
As previously discussed, levies are mainly legislated, often at the request of the industry. However, in most cases, the revenues raised are not allocated exclusively to research; research institutes have to compete with other uses, such as extension and market promotion. In a few cases, the industry may make ad hoc contributions to funding. This is most evident for the Cocoa Research Institute of Ghana, which receives a yearly budget directly from the earnings of the Cocoa Board of Ghana. This is the largest industry-funded research effort in Africa, although it is not strictly a levy.

The institutional arrangements under which the industry funds are allocated to R&D also vary considerably.

- Most common is a legally required levy that is managed by an industry council or board with official status, which then allocates a portion of the funds to a dedicated nonprofit research institute affiliated with that board (for example, tea and sugar in most countries). The influence of producer organizations in these boards may be quite variable. A variant is to have a subregional research institute funded by a levy applied in several neighboring countries. The only current example is the Tea Research Foundation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Commodity</th>
<th>R&amp;D expenditure</th>
<th>Levy</th>
<th>Industry value (2005 PPP dollars (millions))</th>
<th>Specific crop R&amp;D intensity (%)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Public R&amp;D intensity (%)&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana</td>
<td>Cocoa</td>
<td>33.3</td>
<td>32.7</td>
<td>757</td>
<td>4.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Kenya</td>
<td>Tea</td>
<td>3.1</td>
<td>1.7</td>
<td>369</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Kenya</td>
<td>Coffee</td>
<td>5.9</td>
<td>4.4</td>
<td>45</td>
<td>12.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Malawi/Zimbabwe</td>
<td>Tea</td>
<td>2.4</td>
<td>1.4</td>
<td>65</td>
<td>3.7</td>
<td>0.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mauritius</td>
<td>Sugar</td>
<td>9.9</td>
<td>9.4</td>
<td>149</td>
<td>6.6</td>
<td>3.9</td>
</tr>
<tr>
<td>South Africa</td>
<td>Sugar</td>
<td>18.6</td>
<td>na</td>
<td>673</td>
<td>2.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Coffee</td>
<td>3.4</td>
<td>0.4</td>
<td>46</td>
<td>7.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Tobacco</td>
<td>0.1</td>
<td>na</td>
<td>81</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Tea</td>
<td>4.1</td>
<td>na</td>
<td>37</td>
<td>11.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Uganda</td>
<td>Coffee</td>
<td>4.8</td>
<td>1.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>228</td>
<td>2.1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Sources:** Calculated by authors based on ASTI data; industry value data are estimated values of production in purchasing power parity (PPP) dollars 2004–2006 based on FAO (various years).

**Notes:** Research intensity is research expenditures relative to the value of sales expressed as a percentage. na = data were not available. <sup>a</sup>Specific crop R&D intensity refers to levy-funded R&D as a share of industry value of production; public R&D intensity refers to investment in R&D for all public agricultural research as a share of agricultural GDP. Public R&D estimates include levied crop research for Ghana, Tanzania, and Uganda. <sup>b</sup>2001 data. <sup>c</sup>Uncertain estimate. ASTI = Agricultural Science and Technology Indicators; FAO = Food and Agriculture Organization of the United Nations; GDP = gross domestic product; R&D = research and development.
of Central Africa, funded by a levy on tea production in Malawi and Zimbabwe and governed by representatives of both countries.

- A second mechanism is a legally required levy allocated to fund research on a commodity at a public research institute, with varying degrees of industry input into the research program. Cotton in both Mozambique and Tanzania seems to be in this category. In both cases, there have been difficulties in establishing an institutional structure that provides the industry with a sufficient sense of ownership of the funds they provide (Boughton and Poulton 2011).

- Côte d’Ivoire, discussed further below, is a special case, where a council of several producer organizations organizes the collection of the levy and then allocates it to the public research institutes.

Comparing crop-specific research expenditures relative to crop production values (assuming no research is conducted on these crops outside of these institutes) provides an estimate of crop-specific research intensity that can be compared with the research intensity for all public research in each country. In eight cases, crop-specific research intensity supported by industry funding is higher than for overall research intensity. In some cases, research intensity is very high by global standards, although some are small industries (tea in Malawi and Tanzania), or the industry is declining (coffee in Kenya and sugar in Mauritius).

In two cases, tea in Kenya (a large industry) and tobacco in Tanzania (a relatively small industry), crop-specific research intensity is lower than the national average. In industry-managed research institutes, there is also some evidence that spending per scientist is higher than in public institutes (Byerlee 2011).

Currently, collected commodity levies only represent a small share of the potential for levy funding in SSA. To estimate potential, it was assumed that all export crops could be levied, since they pass through one or very few ports, and are relatively easy to implement. Furthermore, in some cases the nature of production or processing could facilitate the collection of levies on commercially oriented production for domestic markets. Sugarcane, oil palm, some other oil crops, and wheat are in this category because they mostly pass through a few fairly large-scale mills. In addition, crops extensively produced under irrigation, such as rice in some countries, are largely commercial and would be easy to levy. Some commercial livestock, such as dairy and poultry production, could also be levied.

In addition, a minimum threshold industry size is needed to introduce a levy because the levy generated has to be large enough to cover the costs of collecting and managing it. Setting an arbitrary threshold industry size of $100 million per
country, a 1 percent levy would generate at least $1 million for R&D, which is sufficient to fund a small research institute. Above this threshold (assuming all large export commodities are levied and about half of the large commercially oriented commodities for domestic markets are levied), the potential total levy would be about $250 million—some five times the amount currently levied for R&D. The potential of levy funding could be greater if regional collective action that could fund R&D on commercial crops in small countries were included. Regional collective action, as already employed for rice in Latin America, would be a logical extension of the current move toward formal regional collaboration in food crop research in Africa. These estimates show the great potential to increase R&D funding through collective action for commercial crops and livestock in SSA.

Case Studies of Levy Funding in Africa

Two cases of levy funding in Africa were chosen for further analysis: (1) multiple products in Côte d’Ivoire and (2) tea in Kenya. Two additional cases from Latin America—the National Agricultural Research Institute (INIA) in Uruguay and coffee and oil palm research in Colombia—were reviewed for comparative purposes; details are provided in Byerlee (2011). The reviews focused on four issues: institutional structure, levels of and trends in funding, evidence of the effectiveness of the research funded, and the role of producer associations in enhancing effectiveness. The two African cases are summarized below, followed by a synthesis of the four cases. Full information on all four cases can be found in Byerlee (2011).

PROFESSIONAL FUND FOR AGRICULTURAL RESEARCH AND EXTENSION, CÔTE D’IVOIRE

The Interprofessional Fund for Agricultural Research and Advisory Services (FIRCA) was established in 2003 as a professional agency operating under private company law to fund research and extension.6 FIRCA is a federation of 14 industry associations (as of 2012), including producers and processors. The associations have a majority vote (73 percent) both in the General Assembly and in FIRCA’s Executive Board, which is appointed by the assembly. Only 5 percent of the seats are allocated to government officials.

Funds are provided through levies on exports (cocoa or rubber) or processed products (palm oil), or in one case on imports (rice), per agreement of the member organizations. A total of about $15 million in levies was collected in 2008, amounting to 0.26 percent of the value of agricultural production, and 0.34 percent of the value of exports in that year. However, four

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6 This section is based on FIRCA (various years).
commodities—cocoa, coffee, palm oil, and rubber—provided 92 percent of the funding. This in part relates to the difficulty of collecting the levy for some commodities (such as poultry and swine for domestic markets) and to the exemption of most food crops, although FIRCA does fund research on these commodities. The levies are all volume based and fixed by the industry association. The actual levy as a share of production value varies substantially, from 0.6 percent for cocoa/coffee, to 1.6 percent for rubber, and 3.1 percent for cotton. FIRCA also receives about 10 percent of its funding from the state.

Industry associations determine the projects to be funded for that subsector; however, research tends to receive a small share of the allocation, depending on the industry, relative to extension. Over the period 2004–2008, FIRCA allocated only 18 percent of its budget to research; 59 percent was allocated to extension, and most of the rest covered administrative costs. The relatively modest amount of the levy and the low share allocated to research mean that research intensity is often low. In the case of cocoa, for example—by far the largest and most important sector—it was only about 0.2 percent of industry value in 2008, compared with 4.4 percent in Ghana.7

FIRCA contracts most research to the National Center for Agricultural Research (CNRA). Originally, the government was to provide 40 percent of CNRA’s funding; however, in practice, this share has been much lower and was only 15 percent in 2008. Presumably, government funding was intended to cover research gaps, especially for noncommercial food crops. FIRCA has attempted to fill this gap through a solidarity fund for food crops but, even so, research on food crops is seriously underfunded.

FIRCA is an interesting example of funding commercial research in Africa. In industries where there is strong buy-in from producers and other industry stakeholders, such as rubber, industry associations are clearly in the driver’s seat in setting the research and extension agenda. However, other industries, such as sugar, remain unconvincing and have not joined FIRCA. Moreover, research investment in key sectors is still low as a share of production value—and is extremely low for the largest sector, cocoa. The associations have tended to prefer short-term gains from extension over longer-term, riskier gains from research. Administrative costs, at 18 percent of the total budget, also seem very high relative to international norms.8

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7 The figures for Côte d’Ivoire include coffee, which is about 10 percent of the value of cocoa.
8 As a general rule of thumb, a research funding agency that does not undertake research should be able to administer the funds with less than 5 percent of the total research expenditures.
**TEA RESEARCH FOUNDATION OF KENYA**

Kenya is the world’s largest exporter of tea, and tea is Kenya’s largest export—amounting to more than $1 billion per year, or 26 percent of agricultural export earnings. Originally, tea was mostly produced on large estates, many in the hands of multinational companies. Over time, with support from government and donors, smallholders have increased their share to now account for 62 percent of national tea production. An estimated 630,000 smallholders have an average of 0.25 hectares, and 63 tea-processing factories are owned by smallholders and managed on a fee basis by the Kenya Tea Development Agency (KTDA), a private company owned by smallholder tea producers. KTDA also provides inputs and advisory services to smallholders. Significantly, the yield gap between smallholders and estates has fallen from 68 percent in 1980 to only 18 percent in 2007 (Mitchell 2012).

The Tea Research Foundation of Kenya (TRFK) was established as a para-statal in 1980 incorporated under the Companies Act to conduct tea research in Kenya. TRFK has a board of 13 members representing various tea organizations, although the majority—including the chair and chief executive officer—are appointed by the government. Smallholder interests on the board are represented by KTDA. TRFK is a small organization with only 13 scientific staff and 124 support staff. TRFK receives more than 80 percent of its funding from a volume-based levy, and the remainder from other sources, including self-generated income. The levy funding as a share of output value has been low and declining—only about 0.1 percent of the production value, which is half of what it was in 2000. Some tea research is conducted by large companies, but combined research intensity on tea is still likely to be well below research intensity estimates for public research in Kenya of 1.3 percent (Flaherty et al. 2010). In addition, TRFK’s expenditures have fallen by more than half in real terms since 2000.

TRFK works closely with the industry in setting its research program and disseminating results; however, smallholders largely participate in governance through KTDA. This has generated criticism that TRFK does not adequately respond to the needs of its clients, and the composition of the board was under review in 2011.

TRFK is generally regarded as being an effective research organization. Salaries are competitive, and scientists have access to a reasonable operating budget, equivalent to the budget for salaries. However, the capital budget has been very small, at less than 2 percent of the 2010 budget.

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9 This section is based on Nzuma (2011).
As already discussed, Kenyan tea is generally regarded as a success story in terms of yields and competitiveness. TRFK products, such as improved clones, agronomic practices, and innovative processing methods, have been widely adopted, especially by smallholders. Kangasniemi (2003) characterized tea research in Kenya as effective but underfunded, and that applies even more today. The very low funding for tea research was recognized as a problem, leading to changes in legislation in 2010 to replace the volume-based levy with a 1 percent \( ad \text{ valorem} \) levy, 40 percent of which was to be allocated to TRFK. Once implemented, this will represent a significant increase in the tea research budget over 2010 levels, but the intensity of tea research would still be below Kenya’s average research intensity for all commodities. The legislation also called for a review of the governance structure of TRFK to allow more direct influence by producers.

**IMPLICATIONS OF THE CASE STUDIES**

What do the cases, including those from Latin America, collectively reveal about the two objectives of implementing produce levies for R&D—increased funding and more accountability? On the first objective, while the levies have increased funding allocated to R&D overall, the contribution has mostly been modest. INIA in Uruguay is the major exception, where the levy is dedicated to R&D, and where, by law, the government must match industry contributions (Byerlee 2011). In other cases, a surprising finding is that little evidence exists to indicate that R&D on commodities funded by levies is better funded than for commodities where R&D is publicly funded. This is because the levy is often small and subject to serious competition from multiple uses, nearly all of which can demonstrate more immediate benefits than can R&D. In fact, it could be argued that some important levied commodities receive less funding than what might have been provided through normal government budgets (coffee in Colombia, tea in Kenya, and cocoa in Côte d’Ivoire). Part of the problem is that most levies are volume based, and adjustment of the levy rate upward in line with rising prices has been slow. These findings on underfunding of R&D on commercial crops are especially critical, given that spill-ins of technology for these crops are likely to be much smaller than those for food crops, an area where CGIAR has a strong regional presence and an explicit mandate to foster spill-ins.

On the second objective of improving the demand orientation and accountability of research, the conclusions are universally positive. All of the cases have developed governance mechanisms to ensure that producers and processors have a strong say in research priorities. There is little
evidence that some large and more politically powerful producers have distorted priorities in their favor. Of course, good governance goes with strong producer and industry organizations, and this is a weakness in many African countries.

Where the research is carried out by a research institute under the control of the producer association or industry board, the research institutes seem to be well managed and productive, relative to public research organizations. They generally have more flexibility in allocating funds between salaries and operating costs, and salaries are competitive—at least with the public sector. And while detailed impact evaluations are not generally available, all can point to significant successes in adoption of their research products.

**Policy Options to Encourage Future Growth in Private Agricultural R&D**

Several policy tools are available to African policymakers should they decide to encourage more private R&D (Table 7.4). The first set of factors involves the business climate for private firms. Although much has changed, as described above, a number of African countries could still stimulate growth by further liberalizing and privatizing agricultural input and processing industries. Kenya is one example. KARI still has a monopoly on foundation seed of public hybrids and varieties, and KSC remains a government corporation, which limits private firms’ share of the hybrid maize seed market and suppresses seed prices. Six of the seven sugar mills in Kenya are owned by the government. The parastatal Central Artificial Insemination Station has a de facto monopoly on the cattle semen market (sustained by regulations limiting who can extract semen, and what foreign bulls are approved).

In some countries, governments need to use their industrial policy to ensure sufficient competition and incentives to conduct research. In South Africa, regulators have brought cases of price fixing against fertilizer producers. In the South African seed industry, antitrust authorities stopped the acquisition of Pannar by DuPont, but their ruling was overturned by the Supreme Court. During negotiations, DuPont agreed to invest in maize for smallholders and to make major new investments in R&D on maize for SSA (Kaskey 2013).

A second set of government policies is government investments and support for public research institutes and research universities. The growth of private seed-industry research in Southern Africa has been based on the research of the International Maize and Wheat Improvement Center (CIMMYT) and
national agricultural research systems. Seed companies are also supported by public–private partnerships, such as the Drought Tolerant Maize for Africa (DTMA) project, which partners CIMMYT and the International Institute for Tropical Agriculture with 13 national research programs and seed companies in the 13 countries. However, shortages of well-trained scientists are a major constraint to the growth of private R&D in all SSA countries—not only in terms of research, but also in terms of the technology regulatory system and science policies. Thus, continued expansion of higher education and PhD training is necessary (Chapters 8 and 9, this volume).

<table>
<thead>
<tr>
<th>Government policy and investment areas</th>
<th>Plantation/processing</th>
<th>Input industries</th>
<th>Levy-based research</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Business climate for private firms</td>
<td>• Allow private investment by local and foreign firms, and reduce the size of parastatals</td>
<td>• Allow private investment by local and foreign firms, and reduce the size of parastatals</td>
<td>• Allow private investment by local and foreign firms, and reduce the size of parastatals</td>
</tr>
<tr>
<td></td>
<td>• Introduce antimonopoly policies to ensure competition</td>
<td>• Introduce antimonopoly policies to ensure competition</td>
<td>• Introduce policies that facilitate collective research funding</td>
</tr>
<tr>
<td>2. Policies to increase the productivity and reduce the costs of private research</td>
<td>• Support NARS contract research and research facilities</td>
<td>• Support NARS provision of advance lines and germplasm to private seed firms</td>
<td>• Support NARS contract research and research facilities</td>
</tr>
<tr>
<td></td>
<td>• Invest in PhD training and university-based research</td>
<td>• Invest in PhD training and university-based research</td>
<td>• Invest in PhD training and university-based research</td>
</tr>
<tr>
<td></td>
<td>• Subsidize venture capital funds and financing for R&amp;D facilities</td>
<td>• Subsidize venture capital funds and financing for R&amp;D facilities</td>
<td>• Provide government funds to match commodity levies</td>
</tr>
<tr>
<td>3. Policies that influence market size</td>
<td>• Reduce agricultural import and export barriers and other measures that tax agriculture</td>
<td>• Reduce agricultural import and export barriers and other measures that tax agriculture</td>
<td>• Reduce agricultural import and export barriers and other measures that tax agriculture</td>
</tr>
<tr>
<td></td>
<td>• Reduce technical barriers on trade in agricultural inputs and harmonize regulations regionally</td>
<td>• Reduce technical barriers on trade in agricultural inputs and harmonize regulations regionally</td>
<td>• Facilitate collective action on R&amp;D at the subregional level</td>
</tr>
<tr>
<td>4. Intellectual property rights</td>
<td></td>
<td>• Improve the enforcement of patents and plant breeders’ rights</td>
<td></td>
</tr>
<tr>
<td>5. Technology regulations and quality control</td>
<td>• Establish government laboratories to ensure product quality</td>
<td>• Reduce efficacy testing on products like seeds</td>
<td>• Establish government laboratories to ensure product quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve control of fake and dangerous inputs</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors.

Note: NARS = national agricultural research system; R&D = research and development.
Other policies could increase potential market size for new technologies and stimulate research. Trade policies, exchange rates, and taxes that reduce the demand for agricultural products still need to be reformed in many SSA countries. Reductions of barriers to regional trade in fertilizer, seed, and other agricultural inputs would be particularly important for input research and technology transfer of inputs. The reduction of badly designed input subsidies that channel input trade through government tenders rather than markets could also provide more space for private-sector input markets. In addition, frequent short-term bans on the export of maize and other products cause sudden declines in prices to farmers and reduce their incentives to invest in modern inputs. Further, relaxation—or at minimum regional harmonization—of technical regulations on agricultural technologies could have a big impact on the pace at which cultivars are introduced and stimulate demand for R&D. Liberalizing tariff and nontariff barriers on technology should increase the quantity and efficiency of private R&D in Africa as a whole by allowing companies to expand their markets for new technology to the region.

Strengthening IPR could provide incentives for increased research in the input industries. For example, even though wheat, soybeans, and cotton are small crops in South Africa, the private sector conducts research on them, in part, because South Africa has strong IPR. In addition, global biotechnology companies are attracted to South Africa because the patent system is effective in protecting their proprietary biotechnology products.

Effective regulations to ensure farmers that the seed or pesticides they buy do in fact have the characteristics advertised on packages can increase the demand for modern inputs. Such regulations can also reduce exposure to dangerous pesticides and other chemicals by reducing or eliminating their use. In addition, regulations allowing the use of safe GM organisms could induce research by seed and biotech companies in some countries.

Finally, African governments and industry associations can do much to exploit the potential of industry levies, which need to be set high enough and, where possible, be dedicated to R&D. Matching government funding can provide a powerful incentive for an industry to impose a reasonable levy on itself. Matching funds can also be justified by spillovers associated with research that go beyond the specific industry. Further, legislating matching funds guarantees a place in national budgets. Despite these advantages, there is still no example of matching funds in Africa, although Côte d’Ivoire tried. Levy-funded research can deliver more efficient and demand-oriented results, whereby strong producer or industry associations ensure an important or even controlling interest in the governance of the funds collected. There are some
short-term opportunities—such as cotton in francophone West Africa, where strong organizations already exist—but elsewhere the development of strong producer organizations is by nature a long-term process. The private sector must initiate the development of such organizations, but governments can help through supporting legislation and grants for capacity building. A second-best alternative would be a reformed parastatal with increasing producer influence, such as provided to cocoa research in Ghana.

Conclusion

SSA has immense potential in commercial agricultural production, but missed out significantly in the commodity boom of the early 21st century. Low productivity resulting from low investment in R&D is one of the main reasons for the poor competitiveness of African agriculture. This can be reversed through greater private investment. Signs indicate that this is starting to happen in the region. Privatization and liberalization combined with higher commodity prices have started the growth of R&D from a low base. Research in the seed industry is growing particularly rapidly, led by the maize seed industry and the entry of several multinational companies, as well as regional expansion of local companies. Most of these companies are emphasizing maize because they can protect their intellectual property through the use of hybrids, even in countries where plant breeders’ rights do not exist or are not enforced.

Research by the plantation and agricultural processing industries is also increasing. African companies, such as Illovo for sugar, now operate in several countries of the region. Also, global companies based in Europe, the United States, India, and Brazil are investing in the African processing industry. These companies bring technology and, when needed, invest in research. Like the input industry, privatization and liberalization, along with increasing African and global demand for agricultural products, have led the way. In both the agricultural input and processing industries, promising trends could lead to rapid growth in R&D. Governments are working to create a better business environment and reduce barriers to trade and foreign investment. IPR and regulations are gradually improving. When India experienced similar trends, private R&D grew rapidly (Pray and Nagarajan 2012).

Collective action to levy commercially oriented industries, for both exports and domestic markets, can provide several times more funding for research than currently, but this outcome is not guaranteed. Strong industry associations, such as in Côte d’Ivoire, have shown the power of R&D funding provided and managed by the relevant industry.
Greater private investment offers much promise to enhance the funding of African R&D and the effectiveness of the R&D carried out with that funding. Combined with an improved policy and business environment, increased private R&D on commercial crops could allow SSA to regain competitiveness and tap a major opportunity for growth. Even so, increased private R&D needs to be combined with other options for promoting R&D on commercial crops, including public funding, enhanced regional collaboration, liberalized seed markets to encourage spill-ins, and technology transfer through foreign direct investment.

Finally, it is often assumed that the promotion of private research will emphasize commercial farming and neglect the technological needs of resource-poor farmers—but this need not be so. It is true that seed companies focus on developing hybrid seeds that are more expensive than open-pollinated seeds that can be saved from year to year. However, smallholder farmers have extensively adopted hybrid maize in Africa; practically all farmers in Zimbabwe use hybrid seed produced by private R&D. The research priorities of private input firms can also be refocused on the problems of poor people, such as drought focusing on DTMA through public–private research partnerships partly funded by donors or governments (for example, for Africa). Levy-based research organizations can be dominated by large farmers, but the review presented in this chapter found little evidence of this. Most important, by stimulating private investment in R&D in selected areas, such as hybrid maize, public resources can be freed to focus on the problems of resource-poor farmers, such as breeding for neglected crops in marginal areas.

References


