Private-Sector Agricultural Research and Innovation in Zambia

Overview, Impact, and Policy Options

Mick Mwala and David Gisselquist

June 2012

Table of Contents

List of Tables

List of Boxes

Acronyms

CAADP	Comprehensive African Agricultural Development Program
CGIAR	Consultative Group for International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CSO	Central Statistical Office
ECZ	Environmental Council of Zambia
FSRP	Food Security Research Programme
GART	Golden Valley Agricultural Research Trust
GMO	genetically modified organism
MACO	Ministry of Agriculture and Cooperatives
MRI	Maize Research Institute
NGO(s)	nongovernmental organization(s)
PASS	Program for African Seed Systems
SADC	Southern Africa Development Community
SCCI	Seed Control and Certification Institute
ZARI	Zambia Agricultural Research Institute

Abstract

With 67 percent of Zambia's labor force engaged in agriculture, increases in agricultural production are crucial to reducing poverty. In order to gain perspective on privately introduced agricultural technology, this study conducted a survey of 31 private organizations, comprising 27 companies, 3 nongovernmental organizations, and one trade association. The sample included companies selling seed and other inputs, managing large farms, or processing agricultural products. Results found that the flow of new technology is much greater through private companies than through public research agencies. For example, during 2000-08, private companies registered 105 maize cultivars vs. eight from public research. Most private technology comes from foreign sources, with less from in-country research. Even so, Zambia has some of the best private maize breeding in Africa. Overall, the study team estimated that private R&D spending totaled about US$2 million in Zambia in 2008, a little more than a quarter of the public research budget that year of US$7.5 million.

Zambia's 2002/03 Postharvest Survey reported that small and medium-sized farms earned almost as much from the sale of vegetables (US$35 million) and livestock products (US$33 million) as from the sale of maize (US$39 million). Private technology—such as vegetable cultivars, irrigation equipment, and chicken breeds and feeds—dominates these subsectors. Private cultivars contributed to Zambia's recent self-sufficiency in maize, wheat, and soybean production. The development of a technologically sophisticated private sector presents new challenges for public institutions in Zambia. Regulations can impede or facilitate the introduction of technology, and one issue that warrants attention is regulatory obstacles to the introduction of new cultivars for major field crops. Through this study, private organizations expressed a desire for tax breaks and education to support private research; they appreciated some ongoing collaborative programs with the government and donors.

INTRODUCTION

Despite Zambia's resurgent mining sector, low productivity on most of Zambia's 1.3 million small farms translates into widespread poverty. With 67 percent of the country's labor force engaged in agriculture, primarily on small farms, substantial increases in agricultural production are crucial to reducing poverty. This in turn requires the introduction and adoption of new and improved agricultural technologies. To develop new agricultural technologies, donors support research in international institutes, such as the International Maize and Wheat Improvement Center (CIMMYT) and other centers of the Consultative Group for International Agricultural Research (CGIAR). Both the government and donors fund research through public institutes, such as the Zambia Agricultural Research Institute (ZARI). Studies have estimated high returns to public agricultural research, often exceeding 50 percent per year (Haggblade 2007).

The African Union's Comprehensive Africa Agricultural Development Program (CAADP) sets a goal of 6 percent annual growth in agriculture. Even higher growth of 7–10 percent per year is projected in Zambia's National Agricultural Policy (2004–15). CAADP projects that half of this growth will come from the use of more inputs (such as fertilizer and labor) and half from improved technology. CAADP's Pillar 4 proposes that new technology will come from public- sector research. This expectation, which is common in donor and government circles, overlooks private-sector activities. In developed market economies, the private sector generates, acquires, and introduces most new agricultural technology. Zambia, like most other countries in Africa, has a market economy. There is so far no systematic study of the contribution of Zambia's private sector to the flow of new and improved technology reaching farmers and agribusinesses.

Box 1. Overview of study purpose and methodology

Because technology is so important to agricultural growth, policies and programs that recognize and promote all channels for the introduction of technology, whether private or public, can be expected to deliver the best growth outcomes. The purpose of this study is to provide information on private innovation and R&D, on the economic and environmental impact of private innovation, and on policies and programs that influence private innovation. Zambia is interesting because of its relatively small population (13.9 million in 2011), as well as its close business links to South Africa, a country with a more advanced agricultural sector.

This study is based on a survey of private organizations, combined with unstructured interviews with company, government, and donor staff, and other studies and documents. Based on prior knowledge, the survey included private companies active in research and the introduction of technology. Thirty-one private organizations responded to the survey, including 27 companies, 3 nongovernmental organizations (NGOs), and one trade association (Table 1).These 31 organizations reported a median of 54 employees (ranging from 3 to 6,000) and median annual sales of US$2.1 million (ranging from US$20,000 to US$113 million). Most organizations sold one or more inputs. The sample included two organizations focused on large-scale crop production (sugarcane and vegetables, and cut flowers for export) and six focused on processing (crops and livestock products).

Table 1. Number of organizations surveyed by type of organization and activity

Activity	Private organizations for which this is the main activity						Total sampled organizations with this activity
					Organization size		
	Total	Locally owned company	Foreign-owned company	NGO/ other	Median sales US$1,000s (range)	Median employees (range)	
Total private	31	10	17	4	2,100 (20–113,000)	54 (3–6,000)	–
Input supply	23	8	12	3	One		
Seed	6	3	3	–	7,300 (1,600–13,000)	52 (9–174)	13
Fertilizer	2	1	1	–	42,000	80 (80–80)	8
Pesticide	5	2	3	–	770 (690–850)	19 (10–28)	8
Machinery	4	1	2	1	480	25 (25–25)	10
Livestock and fisheries	4	1	3	–	2,100	150 (21–200)	9
Advice	2	–	–	2	–	3	13
Large-scale production	2	1	1	0			
Crops	2	1	1	–	NR	6,000	9
Livestock	–						4
Processing	6	1	4	1			
Crops	4	1	3	1[a]	67,000 (20,000–114,000)	240 (17–839)	7
Livestock	1	–	1	–	3,200	200	3

Source: Compiled by authors from study survey.
Note: NR indicates that data are not reported.
a. The trade association.

STUDY FINDINGS: THE INTRODUCTION OF PRIVATE TECHNOLOGY

Twenty of the 27 companies in the study sample operate in two or more countries. Seventeen are subsidiaries of foreign companies whose home offices are located in the Republic of South Africa (6 companies), India (3 companies), the United States (2 companies), and one each for Canada, China, Italy, Switzerland, the United Kingdom, and Zimbabwe. Three of 10 local companies (a seed company, pesticide company, and feed company) reported one or more foreign subsidiaries.

Agricultural Innovation

Companies of all sizes innovate to reduce costs as well as to provide products that farmers and others want; innovations are the "lifeline" of private commercial undertakings. Private organizations reported a wide range of innovations in the five years to 2009, including technologies embodied in inputs (seed, pest control products, granular fertilizers, chicken breeds, livestock semen, feeds), milling technologies, irrigation equipment, agronomic practices (conservation tillage), and others (Table 2). A number of innovations, such as the heat-tolerant New Castle vaccine for poultry, were noted to be in the pipeline, but have not yet reached the market.

Table 2. Examples of new products or processes introduced in the five years to 2009

Product type	Examples of innovations
Inputs	
Seed	New cultivars (maize, cotton, vegetables, and so on); true potato seed; seedlings
Fertilizer	Granular fertilizer; fertilizer blends for vegetables, inoculants
Pesticide	New active ingredients
Machinery	Irrigation equipment; land preparation tools (for conservation farming)
Livestock inputs	Cattle breeds; computer program to match bulls with cows; goat breeds; quail feed; heat-tolerant vaccines
Agronomic advice	Cell phone–based market information; conservation farming information
Large-scale production	
Crops	Jatropha cultivars; vegetable cultivars (some targeted to the European Union market)
Livestock	Small-holder dairy production guide
Processors	
Crop	Vitamin A fortified sugar; biodiesel, ethanol
Livestock	Poultry meat processing (freezing, smoking)

Source: Compiled by authors from survey data.

The flow of new agricultural technology to Zambian farmers is much greater through private innovation than through public research. For example, during 2000–08, private companies registered 105 maize cultivars vs. only 8 from public research (Table 3). For all other field crops combined, private companies registered 44 cultivars vs. 34 from public research. Similarly, private organizations deliver most innovations in agricultural machinery, chemicals, and processing. On the other hand, public and public–private research develops some important technologies for smallholder farmers (for example, conservation tillage and smallholder dairy and irrigation technologies).

Table 3. Number of cultivars registered for selected major crops by organization, 2000–08

	Private companies											Public	
Cultivar	AFGRI	Buya-bamba	Kamano	MRI	Monsanto	Pannar	Pioneer	Progene	SeedCo	Zamseed	Total private	organi-zations	Total
Maize	3		5	16	6	36	7	3	20	9	105	8	113
Sorghum									1		1	3	4
Pearl millet											0	3	3
Finger millet											0	1	1
Wheat	1					2			7	3	13	4	17
Rice											0	2	2
Beans						3		2	1		6	4	10
Cowpeas											0	1	1
Soybeans				2		1			8		11	2	13
Pigeon peas											0	1	1
Velvet beans											0	0	0
Castor											0	1	1
Groundnuts				1					3		4	1	5
Sunflower				1		3			2		6	0	6
Guar											0	1	1
Cotton											0	1	1
Potatoes		1	2								3	0	3
Cassava											0	4	4
Sweetpotatoes											0	5	4
Total	4	1	7	20	6	45	7	5	42	12	149	42	191

Source: SCCI 2008.
Notes: MRI indicates Maize Research Institute. Public breeders include the University of Zambia, Zambia Agricultural Research Institute, Golden Valley Agricultural Research Trust, and Cotton Development Trust.

One innovation—in marketing—warrants special mention because it is so important for the delivery of input-embodied technology to farmers. Before liberalizing reforms in the 1990s, private inputs companies saw two markets: they sold to large farms through stores in Lusaka and other major cities, and they sold to government, which distributed selected inputs to smallholder farmers through nonmarket channels. Since 2005, this situation has changed rapidly. Input companies are realizing that their largest market is smallholders, who collectively account for an estimated 90 percent of planted area. With this realization, companies selling seed, fertilizer, and other inputs began supporting rapid expansion of Zambia's network of private agri-dealers. For example, in Mumbwa town, about 150 kilometers west of Lusaka, all but one of six shops selling inputs in 2009 had opened in the previous one to three years, and several new shops had already organized 5–10 dealers or agents up to 50 kilometers away in order to get closer to farmers. Several donor programs currently provide training and/or credit to agri-dealers.

The expansion of Zambia's agri-dealer network supports the introduction of input-embodied agricultural technologies. Most such technology—in seed, chemicals, and so on—is suitable for small to large farms. Some large investments, such as tractors, can be hired like taxis and hence "shared" across many small farms. Because inputs provide profits within months, even smallholder farmers are able to invest in the best (most rewarding) inputs.

Source of Introduced Technology

Companies and other private organizations reported various sources for their innovations (Table 4). A large majority of companies reported that at least some of their technology came from foreign sources (most often parent companies, but also other sources). A minority reported innovations from their own in-country research. Only a few reported acquiring technology from others' in-country research (for example, Zamseed licenses cultivars from government research).

Reliance on imported technology could be a cost-saving or risk-reducing strategy, but all for the benefit of the agricultural community in Zambia. If a technology is already available (for example, in another country), it will generally be less costly for companies to buy, license, or copy and introduce it—testing and adapting as necessary—rather than to develop something from scratch. For example, in 2007, Authentic Foods "engaged a West African to carry out research on processing methods for various cassava products" (Lubozhya no date, 21). The company subsequently copied and/or imported cassava processing machinery from West Africa, opening a factory in 2008. The company produces gari, baby porridge (gari plus soy flour), cassava flour, and cassava grains.

The Zambia Sugar Company relies on cane varieties imported from Illova, the parent company in South Africa, which it tests for adaptability in Zambia. A private estate farm, York Farm, which specializes in vegetables and flowers for export, gets its varieties from outside Zambia. In both cases, in-country adaptive research considers choice of imported varieties and agronomic practices, such as the best planting method and irrigation regime. Some organizations produce irrigation equipment, copying or adapting technologies from other countries. Adaptation is also an issue with equipment for land preparation; notably, some imported machinery has been found to be unsuited for Zambia's soils, which can be hard when dry.

The poultry industry benefits from foreign breeds. Breeding stocks are obtained (through licensing) from parent companies abroad, and the multiplication of chickens is done locally before they are sold to farmers, who rear the birds for meat or eggs.

Table 4. Innovation by source of introduced technology

Product	Number of organizations reporting innovations	Source of innovations[a]			
		Developed in Zambia		Imported from:	
		Own R&D	Other R&D	Parent company	Other
Inputs					
Seed	9	2	2	5	1
Fertilizer	2	–	–	2	–
Pesticide	7	–	–	4	3
Machinery	5	2	1	3	–
Livestock and fisheries	5	2	–	3	1
Large-scale production					
Crops	1	–	–	1	–
Processing					
Crops	2	1			1
Livestock	1	1			

Source: Compiled by authors from survey data.
[a]Indicates the number of organizations reporting innovations from each source; organizations may report more than one source.

Similarly, recent innovations in Zambia's biofuel subsector include jatropha varieties and processing equipment. Both types of technology are imported; local jatropha varieties are also available. Some research is done in Zambia on the agronomic aspects of growing jatropha; some of this research addresses the fear that jatropha damages soil.

Private R&D

Many companies surveyed were reluctant to report the details of their R&D programs, citing company policy to keep financial information confidential. Even so, the survey and interviews captured some information on private R&D. Seven organizations reported a total of 25 researchers (4 with PhDs, 8 with MScs, and 13 with BScs); three of these researchers were women (Table 5). Including research technicians and supporting administrative staff, these organizations reported a total of 94 professional staff in their research programs. Professional research staff are usually also responsible for technology promotion or production. The seven organizations reported that their professional research staff (including researchers, research technicians, and supporting administrators) spend a median of 35 percent of their time (ranging from 19 to 70 percent) on research. Three organizations—two companies and an NGO—reported spending a total of US$1.3 million on research in 2008 (Table 5).

The seven companies that provided detailed information on their research programs include two seed companies, one pesticide company, an NGO working with machinery, a company selling livestock inputs, and two companies processing crops. Interviews indicated that other organizations in the sample, including two seed companies and an NGO working with machinery, have in-country research programs. Overall, the study team estimated that the survey captured about half the country's private research staffing and R&D budgets, such that private researchers totaled about 50, and private R&D spending about US$2 million in 2008. With some caveats, survey-based estimates of the private research effort can be compared with the latest data on public agricultural research. In 2008, public organizations invested a total of 8.3 million 2005 purchasing power parity (PPP)[1] dollars in agricultural research and employed 209 full-time-equivalent (FTE) researchers (Flaherty and Mwala 2010). In 2005 PPP dollars, the estimated US$2 million that private organizations spent on research in 2008 is equivalent to PPP$2.2 million. These data on public and private research staff and budgets are not strictly comparable; public research staff and budgets are adjusted to exclude time and money for nonresearch activities; the study team did not collect the detailed information from private companies that would be required to make similar adjustments.

Notably, Zambia has one of the strongest private maize breeding programs in Africa in the Maize Research Institute, a locally owned private company. Other major research-based seed companies, including SeedCo from Zimbabwe, Pannar from South Africa, and Pioneer from the United States, fight for market share by breeding and introducing new maize hybrids as well as new cultivars for wheat, soybeans, and several other crops (Table 2).

Table 5. Researchers, research technicians, support staff, and R&D budgets, 2008

		Research and research support staff										
		Researchers (women)			Research technicians (women)			Support		Total professional staff[a] per organization		
Product type	Organizations reporting researchers	PhD	MSc	BSc	MSc	BSc	Diploma or other	Administrators	other	Number (range)	% time on research, median (range)	R&D budget in US$1,000s, total (range)
Inputs												
Seed	2		3	4	2	1	7	7	1	12 (5–19)	39	670
Pesticide	1			2		3	9	6	8	20	19	NR
Machinery	1		1 (1)					4	6	5	NR	110
Livestock	1	1	1	3 (1)			4	10	15	19	50	NR
Processing												
Crops	2	3	3	4 (1)		2	5	9	6	13 (13-13)	45 (19-70)	490
Total	7	4	8 (1)	13 (2)	2	6	25	36	36	13 (5-20)	35 (19-70)	1,270 (110-670)

Source: Compiled by authors from survey data.
Note: Organizations reporting researchers are considered to have R&D programs; this excludes organizations reporting research technicians only. NR indicates that data are not reported.
a. Includes researchers, research technicians, and supporting administrators.

Based on survey responses from the seven organizations that detailed their R&D programs, the number of research staff employed in private research programs (excluding technicians and other support staff) increased from 16 in 2001 to 25 in 2008 (Table 6). Two of the seven organizations hired their first researcher after 2001. Because these responses do not include data from all or even a majority of private organizations with agricultural research, the data may not reflect the growth in private research programs. From other information, the study team estimated that private R&D had expanded at least as fast as the data in Table 6 indicate.

Table 6. Numbers of researchers (and organizations reporting researchers) by year, 2001–08

Subsector	2001	2002	2003	2004	2005	2006	2007	2008
Inputs								
Seed	4 (2)	4 (2)	4 (2)	4 (2)	4 (2)	4 (2)	7 (2)	7 (2)
Pesticide		1 (1)	2 (1)	2 (1)	2 (1)	3 (1)	3 (1)	2 (1)
Machinery	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	1 (1)	1 (1)	1 (1)
Livestock	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)
Processing								
Crops	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	5 (1)	4 (2)	10 (2)
Total	16 (5)	17 (6)	18 (6)	18 (6)	18 (6)	18 (6)	20 (7)	25 (7)

Source: Compiled by authors from survey data.

STUDY FINDINGS: IMPACT OF PRIVATE TECHNOLOGY INTRODUCTION

Agricultural Production: Fruits, Vegetables, and Animal Protein

Zambia's Central Statistical Office (CSO) reports several types of data showing substantial expansion in production and consumption of high-value food products (fruits, vegetables, and animal protein) from the late-1990s to 2008 (Table 7). CSO's 1996/97 Post Harvest Survey of small and medium-sized farms reported US$4.7 million (K4.9 billion) in vegetable sales vs. US$24 million (K25 billion) in maize sales—showing a 1 to 5 ratio of vegetable sales to maize sales. Six years later, CSO's 2002/03 Post Harvest and Supplementary Surveys (corresponding to the 2003/04 marketing year) reported small and medium-sized farm earnings to be almost as much from the sale of vegetables (US$35 million) and livestock products (US$33 million) as from maize sales (US$39 million).

Table 7. Farm sales and urban consumption of fruit, vegetables, animal protein, and milk products, 1997/98 to 2007/08

Item	1996/97	1997/98	2003/04	2007/08
Number of chickens, small and medium holdings	5.1 million (September 1997)	4.3 million (September 1998)		
Sales of livestock products by small and medium farmers			US$33.2 million K158 billion	
Sales of vegetables by small and medium farmers	US$4.7 million K4.9 billion	US$6.6 million K8.2 billion	US$35.4 million K168 billion	
Sales of maize by small and medium farmers	US$24 million K 25.4 billion	US$28 million K 34.7 billion	US$39.4 million K 187 billion	
Share of urban consumption expenditures for food (Lusaka, Kitwe, Mansa, Kasama)				49–62%
Share for maize (Lusaka, Kitwe, Mansa)				4.7–6.4%
Share for animal protein, fruits, and vegetables (Lusaka, Kitwe, Mansa)				21–23%
Fruits and vegetables				7.1–8.4%
Animal protein (meat, dairy)				14–15%

Sources: CSO 1999, 2000; Zulu et al. 2007; Coming policy attractions 2009.

After another five years, the CSO/MACO/FSRP 2007–08 Urban Consumption Survey (reported in: Coming policy attractions 2009) reported that urban residents (in Lusaka, Kitwe, and Mansa) spent 1.1–1.8 times more on fruits and vegetables vs. maize, and more than twice as much on animal protein (including dairy) vs. maize. Taking all high-value foods together, urban consumers spent roughly thee to five times more on them than on maize. Across the three cities, maize accounted for 4.7–6.4 percent of consumption vs. 21–23 percent for high-value foods.

Notably, the reported increase in urban spending on high-value foods agrees with macroeconomic data showing substantial increases in GDP per capita; as incomes go up, people buy more high-value foods. Further, because marketing margins for perishable high-value foods (fruits, vegetables, and animal protein) are higher than for maize, data showing farmers earning almost twice as much from high-value products vs. maize agree with data showing urban consumers spending almost four times as much for high-value products vs. maize.

Private companies account for much of the technology that farmers use to produce vegetables and livestock products. Specifically, production of vegetables for sale, especially off-season production, depends on cultivars and minor irrigation equipment (treadle pumps, low-cost diesel engines, lay-flat hose, and so on) introduced by private companies and NGOs. Zambia's poultry production has been expanding with privately introduced breeds, feeds, equipment, and

pharmaceutical products. From 2000, poultry production expanded at an estimated 20 percent per year before a temporary setback in 2007 due to high grain prices and consumers' fear of avian influenza. For milk production, private companies and the government's Golden Valley Agricultural Research Trust (GART) introduce cows with improved genetic potential and technologies for silage and milk collection.

Agricultural Production: Major Field Crops

From the mid-1990s, private seed companies have bred and/or selected and registered in Zambia more than 100 maize cultivars, mostly hybrids with yield potential exceeding 10 tons per hectare. However, average yields remain low. Yields averaged 1.6 tons per hectare during 1990–2005 (Langyintuo et al. 2008). The estimated maize yield in 2008/09—which was considered to be a good year—was a similar 1.6 tons per hectare of planted area, but 2.1 tons per hectare on harvested area (CSO 2009a). Even so, Zambia's average maize yields during 1990–2005 were better than for all countries in Southern and East Africa except South Africa and Kenya. Zambian farmers plant an estimated 73 percent of maize area to commercial seed, more than in most other countries in Africa. . Farmers buy a large majority of this seed, most of which is for hybrids, at full cost through agri-input dealers and agents, even though the government distributes subsidized maize seeds through the Food Security Programme.

After 2000, Zambia reached self-sufficiency in wheat and soybeans, based largely on cultivars introduced by private seed companies.

Despite some private initiatives, biofuels have yet to take off. In the early 2000s, D1 Oils embarked on an out-grower scheme to produce jatropha, which it processed into diesel fuel. After a few years, the company folded, citing absence of policies supporting use of biofuel (compared with Zimbabwe, for example, where the government encouraged use of ethanol blends in vehicles).

During this period, farmers have had mixed success with crops dominated by varieties from public research. From the early 1990s, farmers expanded production of cassava, sorghum, and sweet potatoes, planting varieties from public research. These crops have improved food security and crop diversity, which is good for soils. Farmers' experience with cotton has been less positive. From 1989–90 to 2007–08, planted area increased from 64,000 to more than 140,000 hectares (World Bank 2006). However, due at least in part to disappointing prices, cotton area fell by 28 percent in 2008–09 (CSO 2009a). Notably, farmers see few varieties for cotton, all of which come from the Cotton Development Trust, a public institute. Further, ginners control seed sale, unlike many other countries such as India, where seed companies not only produce and supply cotton seed but also introduce new cultivars from their own and others' breeding.

Agricultural Growth and Poverty Reduction

CSO reports steady growth in Zambia's economy during 2000–08, with GDP in constant 1994 prices increasing an average of 5.1 percent per year. During this period, population growth averaged 3 percent per year, so that per capita GDP increased approximately 2 percent per year. Population growth directly increased demand for food by 3 percent per year; while the 2 percent annual increase in income per capita increased demand for food by an additional 1.6 percent (Zambia's income elasticity of demand for food is 0.8 [ERS 2011]). Thus, 5.1 percent growth in GDP during 2000–08 corresponds to food consumption increasing at least 4 percent per year. With no major change in net agricultural exports over the period, 4 percent is a good estimate for average growth in agricultural production. Paradoxically, Zambia's CSO reports that agricultural production fell an average of 0.5 percent per year during 2000–08 (CSO 2009b); this dismal view does not fit information on macroeconomic growth, farm sales, and urban consumption. Looking at all the evidence, Zambia's agricultural sector appears to have grown and diversified from 2000 (Jayne et al. 2007).

Available data on poverty show little or no impact from agricultural growth after 2000. From 1990 to 2002/03, spanning a decade of painful economic reforms, the percentage of rural people classified as extremely poverty fell from 81 to 52 percent, (Jayne et al. 2007). According to the latest data, 51 percent of Zambians were extremely poor in 2006 (only 16–27 percent in Lusaka and Copperbelt Provinces, but 57–73 percent in the other 7 provinces [CSO 2009a]). However, anecdotal information suggests that private technology has improved incomes for smallholder farmers over the past decade. Small and medium-sized farms produce most high-value vegetables. Much of the recent expansion in poultry production comes from hundreds of farms managing 50 to several hundred birds each. Smallholder farmers provide an increasing proportion of milk for the formal sector (although 10 large farms currently dominate the sector). Similarly, small farms produce most maize, while large farms produce most wheat and soybeans.

The Environment

Based on the types of agricultural technology introduced by private organizations, one can infer a mixed impact on the environment and public health. Through the 1980s, soil fertility fell with maize mono-cropping and pan-Zambian fertilizer recommendations (that often did not fit soil conditions). From the early 1990s to the present, crop diversification with public cultivars for cassava, sweet potatoes, and sorghum, and private cultivars for beans, soybeans, groundnuts, wheat, and sunflower has provided some relief for soils. However, neither the government nor other organizations have so far committed to help smallholder farmers move away from standard fertilizer applications to fertilizer use based on soil tests and local conditions (with lime, missing elements, micronutrients, and so on).

Private technology has increased pesticide use, which has impacts for the environment and public health. Introduction and (so far limited) adoption of conservation tillage is good for soils, and allows smallholder farmers to plant larger areas through dry season land preparation; however, conservation tillage also increases herbicide use. Farmers use pesticides on vegetables to protect their investment in high-value crops. There is so far little information on the environmental impacts of pesticide use in Zambia, or on the health impact of pesticide residues.

STUDY FINDINGS: PROGRAMS AND POLICIES AFFECTING THE PRIVATE INTRODUCTION OF TECHNOLOGY

Government and donor actions can and do have a big impact on private agricultural innovation and R&D. Through questionnaires and interviews, people consulted during this study discussed current policies and programs, and suggested changes to facilitate and support private innovation and R&D.

Technical Support to Private Organizations

Zambia's public agricultural research organizations include the Zambian Agricultural Research Institute (ZARI), five other institutes, six universities, and two trusts. Public research has had an uneven history over the past 20 years. As of 2008, the number of research staff recovered to near the levels in the early 1990s: 209 full-time equivalent researchers, with approximately 800 support staff (Flaherty and Mwala 2010). The government spent US$7.5 million on agricultural research in 2008, more than in recent years, but far less than in the early 1990s (an estimated 73 percent less in PPP dollars). About half of public-sector researchers are qualified to the PhD or MSc level, with the rest having BSc degrees.

During this study, private organizations appreciated some ongoing collaborative research with government and/or donors, and asked for more technical support for private innovation from the government. Several seed companies wanted the University of Zambia to prepare graduates for their breeding programs. The Program for African Seed Systems (PASS), supported by the Bill and Melinda Gates Foundation, provides scholarships to develop breeders. PASS training favors breeders from the public sector; well-trained breeders are also needed in the private sector.

Some seed companies criticized unequal access to cultivars from public breeding. In the 1900s, ZARI established a policy to license its cultivars exclusively to Zamseed. In 2003, ZARI modified this policy, giving Zamseed first choice of cultivars, then allowing other seed companies to bid on remaining ZARI cultivars.

Some ongoing projects support private companies to develop and distribute inputs that embody new technology. For example, International Development Enterprises, an international NGO, helps companies to make and sell irrigation equipment, including treadle pumps and drip irrigation systems. The Conservation Farming Unit, a local NGO, works with private companies to develop, identify, and produce farm machinery suitable for conservation tillage. USAID's Profit project, in partnership with Land O' Lakes, works with private companies to develop and market technologies for small-scale dairy production.

Several government research organizations intend to collaborate with private companies in agricultural research. GART works with private seed companies to test and demonstrate new cultivars. GART also collaborates with the Zambia National Farmers Union and Conservation Farming Unit to develop and extend conservation farming techniques. The Cotton Development Trust conducts breeding and agronomic research on cotton. Both Trusts are heavily dependent on donor and government support, with only a minority of funds coming from the private sector.

Financial Support to Private Organizations

Companies, especially those with R&D programs, asked for financial assistance through tax breaks, and also grants for research. For example, seed companies pay VAT on equipment imported for research, but are not able to recover VAT on seed sold (because seed is exempt from the tax). In coming years, in conjunction with CAADP, donors and government are expected to increase financial support for agricultural research, with some grants going to private research.

Removing Barriers to Agricultural Exports

Input companies, farmers' organizations, and policy experts criticized maize export controls. By reducing farm-level maize prices, export controls indirectly depress input sales, which reduces companies' ability to deliver technology embodied in seeds, fertilizers, and other inputs. For most of the past several decades, subsidized maize imports and maize export controls depressed maize prices far below import parity levels. Low prices discouraged production. As a consequence, Zambia has been food insecure, depending on imports. During 1990–2005, Zambia's annual net maize imports averaged more than 100,000 tons—more than 10 percent of consumption.

With higher grain prices due to tight world markets over the past several years, Zambia's farmers have demonstrated that they can produce enough to supply regional as well as national markets. The "national food balance sheet" for the 2009–10 marketing season projects net exports of grains plus roots equivalent to more than 20 percent of production (CS0 2009b). Removing maize export controls and encouraging farmers to produce for export is a good way to improve food security; if Zambia could become a consistent maize exporter, exports might fall in bad years, but there would be enough for local demand.

Removing maize export controls to allow higher maize prices would be good not only for technology transfer and food security, but also poverty reduction. Higher maize prices boost incomes and jobs across the board in rural areas, which is where most poor people live. Furthermore, maize no longer dominates budgets for the urban poor: low-income people in Lusaka, Kitwe, and Mansa in 2007–08 spent almost much on rice, wheat, and cassava (5–7 percent of consumption expenditures) as on maize (7–9 percent of consumption expenditures).

Designing Regulations to Facilitate the Introduction of New Technology

Low risk pesticides

The Environmental Council of Zambia (ECZ) regulates pesticides (including biological pesticides) and fertilizers. Companies complained about fees: ECZ charges each company US$500 per product per year. Fees are a particular problem for safer products that are better for the environment, such as pheromones to control insects, and inoculants to control nematodes. Safer products characteristically target a specific pest species and thereby have smaller potential markets than broad spectrum poisons. In the United States and Europe, regulations often favor safer products; along the same lines, Zambia could consider lower fees for nonpoisonous pest control products, such as pheromones and inoculants.

Table 5. Some agricultural innovations that require government approval

			Process to regulate innovation	
Product type	**Innovations requiring approval**	**Agency that regulates innovation**	**Time required**	**Expense**
Seed	New field crop cultivars (except forage crops)	Seed Control and Certification Institute	Two years	Approximately US$2,500
Pesticide	New products	Environmental Council of Zambia	Weeks	US$500 per product per year
Fertilizer	New products	Environmental Council of Zambia	Weeks	
Livestock breeds	Imported breed	Herdbook Society of Zambia	Weeks	Variable
Livestock feeds	New feed formula	Zambia Bureau of Standards	Weeks	
Veterinary pharmaceuticals	New product, supplier	Pharmaceuticals Board of Zambia	Weeks	Variable depending on product

Source: Compiled by authors from survey data.

Seed

Discussions and responses to questionnaires touched on a number of regulatory issues for seeds**.** The regulatory issue most important for technology transfer and research in seeds is whether and how government controls introduction of new cultivars. Current regulations allow companies to introduce new cultivars for vegetables, forage, and fodder crops without fees or official trials and approvals. However, to introduce a new cultivar for other field crops, SCCI requires two years of official tests followed by an official review before deciding whether or not to allow a company to sell seeds of that cultivar. Companies commonly conduct their own field trials of prospective cultivars before submitting them to SCCI for official trials. Several seed companies reported paying circa US$2,500 (K10,000,000) for fees and tests to register a new cultivar; fees depend on the number of sites where the cultivar is tested. Seed companies also reported some negative decisions; SCCI rejected cultivars that companies thought farmers would appreciate. In one situation, a company saw an opportunity to produce beans of a specified cultivar for export to South Africa, but because it would take SCCI several years to approve the cultivar, prospective exporters abandoned their plans. From the late-1990s, Zambia has taken part in discussions through the Southern Africa Development Community (SADC) to "harmonize" seed regulations. The proposed harmonization would, inter alia, create a list of cultivars for which seeds could be sold in all SADC countries; the list would include cultivars approved by at least two member countries after two years of tests, and further approved by a SADC committee. In addition to SADC's proposed harmonization initiative, Zambia could consider unilateral measures to make it easier for companies to introduce new cultivars for maize, cotton, millet, sorghum, pulses, and other field crops.

Other regulatory issues warrant some comments. SCCI requires seed certification for all seeds produced in Zambia. While SCCI licenses staff from several large seed companies to certify their company's seed, certification can be expensive for smaller companies, especially companies producing nonhybrid and thus cheaper seed for self- and open-pollinated

varieties and vegetatively propagated crops. Notably, many countries (for example, India and the United States) allow companies to sell uncertified but truthfully labeled seed. Zambia does not allow genetically modified organisms (GMOs); several individuals associated with organizations breeding maize and cotton favored GMOs, while others appreciated the current ban. Finally, several companies expressed frustration with fake seed packaged to look like theirs; this can be addressed with existing criminal law, as well as civil suits.

Livestock Inputs

Regulations govern the introduction of new feed formulas, breeds, and veterinary pharmaceuticals. The Bureau of Standards tests and approves new feed formulas. The poultry industry appreciates current strict controls on veterinary pharmaceuticals, which assure quality. Zoosanitary controls on imports of live birds assisted hatchery development in Zambia (government charges US$200 per bird for import permits, and quarantines birds for up to 13 weeks at the company's expense). With the threat of diseases such as avian influenza, the poultry industry respects these controls, even though they add cost. Government controls import of cattle semen according to performance as well as zoosanitary concerns; although government attention to performance is a potential obstacle to private technology introduction, no one complained about not being able to import semen from specific bulls.

Intellectual Property Rights

In 2007, Zambia passed a law establishing plant breeders' rights, but regulations are not yet issued, and the law is not yet enforced. Several companies considered the law would have some influence on their efforts to introduce new nonhybrid wheat and soybean cultivars from other countries, as well as from in-country breeding. On the other hand, no seed company linked the new law to hybrid maize breeding or seed production in Zambia. Similarly, no one linked the new law to cut flowers; reportedly, the sale of flowers from pirated cultivars could be blocked in international markets, so that ownership can be enforced without registering plant breeders' rights in Zambia.

No company expressed any concerns about patents for agricultural chemicals or machinery in Zambia. Patents are more important in producing than in importing countries.

CONCLUSIONS

Liberalizing and privatizing reforms in the 1990s brought new company entry and competitive markets for a range of agribusinesses. Private agri-businesses have been accessing and introducing agricultural technologies from around the world. In-country private research adapts imported technologies, and in some cases, such as in maize breeding, makes substantial advances. Some Zambian agribusiness companies are expanding into neighboring countries.

Technologies from private companies have had a big impact on small-farm production of high-value products, especially vegetables and poultry. This in turn has contributed to improved diets across Zambia. Private cultivars for maize, wheat, and soybeans have helped Zambia to achieve self-sufficiency in these crops in recent years.

The development of a technologically sophisticated private sector presents new tasks and opportunities for public institutions. Zambian agribusinesses look to government for educated staff and technical assistance. With agribusinesses taking initiatives to import and introduce new technologies, it is a constant challenge to get regulations right so as to protect the environment and public health without discouraging new technology. CAADP's target to achieve 6 percent annual agricultural growth, with half of that growth coming from new technology, is not possible based solely on technologies coming out of public research. Recognizing, allowing, and supporting privately introduced technology can make these goals realistic.

BIBLIOGRAPHY

ACF (Agricultural Consultative Forum). 2009. Proposed reforms on the Fertiliser Support Programme for Stakeholder Review. <http://www.acf.org.zm/> (accessed August 25, 2009)

CSO (Central Statistical Office, Zambia). 2009a. *The Monthly.* 76 (July).

_____. 2009b. *The Monthly.* 74 (May).

_____. 1999. *Agricultural and Pastoral Production (Small and Medium Scale Holdings) 1996–97 Structural Type and Post-Harvest Data* (Executive Summary Only, Tables 5a, 8, 9.). Lusaka. http://www.aec.msu.edu/fs2/zambia/agpastoralprod.pdf (accessed 22 June 2012).

_____. 2000. *Agricultural and Pastoral Production (Small and Medium Scale Holdings) 1997-98 Structural Type and Post-Harvest Data* (Executive Summary Only, Tables 7a, 7d, 12.). Lusaka. http://www.aec.msu.edu/fs2/zambia/ag_and_pastoral_production_97_98.pdf (accessed 22 June 2012).

Coming Policy Attractions. 2009. "An Overview of On-Going Research & Potential Outreach." Presentation for Discussion at a Meeting of Donor Cooperating Partners and The ACF/FSRP Research/Outreach Team. Lusaka: Agricultural Consultative Forum. <http://www.aec.msu.edu/fs2/zambia/Coming_Policy_Attractions_mtw1.pdf>

Dorosh, P., S. Dradri, S. Haggblade. 2007. Alternate Instruments for Ensuring Food Security and Price Stability in Zambia. Working Paper No. 29. Lusaka: Food Security Research Project. <http://www.aec.msu.edu/agecon/fs2/zambia/index.htm>.

ERS (Economic Research Service of the United States Department of Agriculture). 2011. International Food Consumption Patterns. Data Sets <http://www.ers.usda.gov/Data/InternationalFoodDemand/> (accessed May 29, 2011).

Elliot, H., and P. T. Perrault. 2006. Zambia: A Quiet Crisis in African Research and Development. In Pardey, P. G., J. M. Alston, and R. R. Piggott, *Agricultural R&D in the Developing World: Too Little, Too Late?* Washington DC: International Food Policy Research Institute.

The Fertilizer Review Team. 2009. Presentation of the Study Team on Proposed Reforms of the Fertilizer Support Programme (FSP). Lusaka: Agricultural Consultative Forum <http://www.acf.org.zm/> (accessed August 25, 2009).

Flaherty, K., M. Mwala. 2010. *Zambia: Recent Developments in Agricultural Research.* ASTI Country Note. Washington, DC: International Food Policy Research Institute.

Haggblade, S. 2007. *Returns to Investment in Agriculture.* Policy Synthesis No. 19. Lusaka: Food Security Research Project <http://www.aec.msu.edu/agecon/fs2/zambia/index.htm>.

Haggblade, S., T Jayne, D. Tschirley, S. Longabaugh. 2008. Potential for Intra-Regional Maize Trade in Southern Africa: An Analysis for Zambia at the Sub-National Level. Working Paper No. 35. Lusaka: Food Security Research Project <http://www.aec.msu.edu/agecon/fs2/zambia/index.htm>.

Jayne T. S., J. Govereh, P. Chilonda, N. Mason, A. Chapoto, and H. Haantuba. 2007. *Trends in Agricultural and Rural Development Indicators in Zambia.* Working Paper No. 24. Lusaka: Food Security Research Project <http://www.aec.msu.edu/agecon/fs2/zambia/index.htm>.

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

Lubozhya, B. No date. Cassava market research for the project Media campaign. Lusaka: Zambia Episcopal Conference, and FAO.

Lungu, T., A. Mutelekesha, A. Chapoto, M.t Beaver, M. Weber. 2009. Categorization Tables: Small and Medium-Scale Household Income and Other Characteristics By Quintile of Household Per-Capita Land Use, 2004. Lusaka: Agricultural Consultative Forum <http://www.acf.org.zm/> (accessed 25 August 2009).

MACO (Ministry of Agriculture and Co-operatives, Government of Zambia). 2004. *National Agricultural Policy, 2004–15.* Lusaka.

Ministry of Finance and National Planning, Government of Zambia. 2006. *Fifth National Development Plan, 2006-10*. Lusaka.

SCCI (Seed Control and Certification Institute). 2008. *Official Variety List, 2008.* Lusaka.

Sifukwe, M. 2006. *Relief Seed Trade Study Zambia.* Harare: Food Agriculture, and Natural Resources Policy Analysis Network (FANRPAN).

Study Team. 2009. Report on Proposed Reforms for the Zambian Fertilizer Support Programme. Lusaka. Agricultural Consultative Forum <http://www.acf.org.zm/>.

World Bank. 2006. *Zambia: Agricultural Development Support Project, Project Appraisal Document.* Washington, DC.

ZNFU (Zambia National Farmers' Union). 2009. Agriculture Sector: Citizen Economic Empowerment Draft Sector Code (Charter), first version (March). Lusaka.

Zulu, Ballard, T. S. Jayne, and M. Beaver. 2007. Smallholder Household Maize Production and Marketing Behavior in Zambia and its implications for policy. Working Paper No. 22. Lusaka: Food Security Research Project <http://aec.msu.edu/fs2/zambia/wp_22.pdf> (accessed May 31, 2011).

Mick Mwala (mmwala@unza.zm; mmwala@yahoo.com) is dean of the School of Agricultural Sciences at the University of Zambia and **David Gisselquist** (david_gisselquist@yahoo.com) is a consultant with Rutgers University, Newark, New Jersey, USA.

This paper on Zambia is part of a study of private agricultural innovation and R&D in eight countries funded by the Bill and Melinda Gates Foundation during 2008–10. The study was collaboratively managed by the International Food Policy Research Institute (IFPRI), Rutgers University (United States), and McGill University (Canada). Other countries included in the study were Bangladesh, India, Kenya, Pakistan, South Africa, Senegal, and Tanzania.

Carl Pray (pray@aesop.rutgers.edu), **David Spielman** (d.spielman@CGIAR.org), and **Anwar Naseem** (anwar.naseem@mcgill.ca) co-direct the study. The authors thank Clarement Laki for his skilled and committed assistance with the survey and data entry and staff at the International Food Policy Research Institute for help in revising and preparing this report. This study has not been peer reviewed. Any opinions herein are those of the author(s) and do not necessarily reflect the policies or opinions of IFPRI, its partners, or collaborators.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

Supported by the CGIAR

McGill