Chapter 10

Brazil: Maintaining the Momentum

Nienke M. Beintema, Philip G. Pardey, and Flavio Avila

Introduction

After a period of slow or no growth during the late 1970s and 1980s, public agricultural research investments in Latin America rebounded during the early 1990s.[1] These regional trends were heavily influenced by developments in Brazil, which accounted for close to half of the region's total agricultural research expenditures (Beintema and Pardey 2001). Consequently, developments in Brazilian agricultural R&D are of great significance to the rest of the region and to the developing world more generally.[2] But agricultural research investment has grown much more rapidly in Brazil than in many other Latin American countries, reaching intensity ratios close to those found in the developed world.

Central to agricultural R&D in Brazil is the Brazilian Agricultural Research Corporation (Embrapa), created in 1972. In addition, Brazil has a large number of state government agencies, numerous faculties and schools of agriculture, and some nonprofit agencies conducting agricultural research. Brazil has an active and growing private sector—involving for-profit enterprises and various multinational companies—providing technologies and technical services concerned mainly with farm inputs; most of these technologies, however, appear to represent spillins to Brazil from research done elsewhere.

Macroeconomic Context

As in many of its neighboring countries, Brazil's economy grew briskly during the 1970s and 1980s, but this growth was followed by a series of economic crises, including bouts of hyperinflation, shrinking levels of output, and increasing rates of unemployment. After strong efforts by the government to stabilize the Brazilian

economy—including a number of significant currency devaluations—inflation rates declined, and the economy strengthened during the mid-1990s, though it fell into crisis again during the late 1990s and appears to have recovered only slightly since then. Agriculture's share of total GDP fell from 12.3 percent in 1970 to 5.8 percent in 2002 (Table 10.1). In 2002, 15.6 percent of the labor force worked in the agricultural sector (FAO 2005).

Traditionally, the Brazilian government has pursued import-substituting industrialization policies, despite the country's abundance of natural resources and comparative advantages in agricultural and wood products. Following the trade-liberalizing policy reforms introduced in the early 1990s, production and productivity in crop and livestock products have increased substantially (EIU 1998). Brazil is a significant exporter of several agricultural products. However, the share of agricultural goods in total merchandise exports decreased from 71 percent in 1970 to only 23 percent in 2000. The main agricultural export commodities were sugarcane, coffee, and soybeans, which accounted for 17, 14, and 9 percent of total agricultural export revenues, respectively. Brazil is the largest coffee producer in the world and the second-largest producer of soybeans (following the United States) and sugarcane (following India). Soybean production has increased substantially in recent years, replacing production of other food crops such as beans and rice (EIU 1998 and IBGE 1999).

Historical Developments and Current Structure of Agricultural Research

Historical Developments

Formalized agricultural research began in Brazil in the mid-1800s with the establishment and operation of two imperial research institutes, one in Rio de Janeiro and one in Bahia.[3] In 1887, the federal government established the Imperial Agronomic Station of Campinas.[4] This station was transferred to the state government of São Paulo only a few years later and renamed the Agronomic Institute of Campinas (IAC), which still exists today. Following a period of deterioration of existing agricultural research facilities (with the exception of IAC) at the end of the 19th century, a number of agricultural research institutes and experiment stations were established and coordinated by the government. Mostly located in the richer states, these focused on export crops like cotton and sugarcane. The world economic crisis of the 1930s, collapsing coffee prices, and the subsequent shifting emphasis of the Brazilian economy from agriculture to industry led to several rounds of reorganization of the Federal Ministry of Agriculture and the Secretariat of Agriculture of the

Table 10.1 Brazil: Overview of agricultural indicators, 1970–2002

Indicator	1970	1980	1990	2000	2002
Agricultural sector as a percentage of					
Total GDP	12.3	11.0	8.1	7.3	5.8
Total labor force	47.2	36.7	23.3	16.7	15.6
Agricultural imports					
Total (million 2000 U.S. dollars)	1,055.3	4,575.3	2,767.3	4,279.0	3,115.4
As a percentage of total merchandise imports	10.4	9.9	10.1	7.3	6.5
Agricultural exports					
Total (million 2000 U.S. dollars)	6,951.3	17,260.2	10,687.5	12,761.3	16,089.1
As a percentage of total merchandise exports	71.1	46.3	27.9	23.2	27.7
Agricultural area (million hectares)	195.4	224.3	241.6	261.4	263.6
Permanent pasture (million hectares)	154.1	171.4	184.2	196.2	197.0
Arable and permanent crops (million hectares)	41.3	52.9	57.4	65.2	66.6
Main crops					
Coffee					
Total production (million metric tons)	0.8	1.1	1.5	1.9	2.6
Area under production (million hectares)	2.4	2.4	2.9	2.3	2.4
Average yield (metric tons per hectare)	0.3	0.4	0.5	0.8	1.1
Total value of exports (million 2000 U.S. dollars)	3,354.5	4,603.8	1,349.1	1,559.6	1,150.0
Sugarcane					
Total production (million metric tons)	79.8	148.7	262.7	327.7	363.7
Area under production (million hectares)	1.7	2.6	4.3	4.8	5.1
Average yield (metric tons per hectare)	46.2	57.0	61.5	67.6	71.3
Total value of exports (million 2000 U.S. dollars)	452.3	2,385.8	639.7	1,199.4	2,013.9
Soybeans					
Total production (million metric tons)	1.5	15.2	19.9	32.7	42.1
Area under production (million hectares)	1.3	8.8	11.5	13.6	16.4
Average yield (metric tons per hectare)	1.1	1.7	1.7	2.4	2.6
Total value of exports (million 2000 U.S. dollars)	96.7	729.5	1,109.7	2,187.9	2,916.6
Oranges					
Total production (million metric tons)	3.1	10.9	17.5	21.3	18.5
Area under production (million hectares)	0.2	0.6	0.9	0.9	0.8
Average yield (metric tons per hectare)	15.3	18.9	19.1	24.9	22.4
Total value of exports (million 2000 U.S. dollars)[a]	64.9	654.7	1,813.2	1,049.9	844.2
Maize					
Total production (million metric tons)	12.2	20.4	21.3	31.9	35.9
Area under production (million hectares)	9.9	11.5	11.4	11.6	11.8
Average yield (metric tons per hectare)	1.4	1.8	1.9	2.7	3.1
Total value of exports (million 2000 U.S. dollars)	287.8	2.1	0.2	9.4	257.4

Sources: World Bank 2005 and FAO 2005.

[a]Includes oranges and orange juice.

state of São Paulo, and to declining support for agricultural research. A military government was formed in 1964, leading to a further round of reorganization of federal agricultural research in subsequent years.

In 1973, following an evaluation of the federal agricultural research system by a special committee appointed by the minister of agriculture, Embrapa was created as a public corporation, a status that gave it more freedom in its financial and human-resource policies. During its early years, Embrapa focused on applied research, which was undertaken in national commodity and regional centers throughout the country. During the 1970s and early 1980s, funding for Embrapa increased markedly, and the agency achieved significant research results. But, beginning in the mid-1980s, the government suffered a series of financial crises, which resulted in severe budget cuts for most public agencies. During the 1990s, Embrapa underwent two major reorganizations under new boards of directors. The changes involved, among other things, refocusing the agency's research priorities toward the perceived needs of Embrapa's clients and end users, decentralizing some administrative management aspects, and strengthening collaborations at the national and international levels.

During the 1960s, agricultural research by state governments was insignificant except in São Paulo, Rio Grande do Sul, and Pernambuco. In São Paulo, four additional state agricultural research agencies were established during the 1960s, bringing the state's total to six and forming the largest state agricultural-research system in Brazil.[5] During the 1970s and continuing into the 1980s, Embrapa stimulated the creation of state corporations for agricultural research based on its own (semi-public) model, which allowed greater flexibility in management practices. As a result of the aforementioned financial crises, state support for agricultural research declined after the mid-1980s. Most states suffered from financial crises and poorly managed public institutions, and the return to democracy in 1986 politicized many of the state governments in ways that negatively affected agricultural research agencies, especially in the northeast—the poorest region of the country (Alves 1992). As a result, over the ensuing years, a number of state agricultural research agencies were closed or merged with state extension agencies.

The first agricultural school to have a significant research program was the Luis de Queiroz Higher School of Agriculture, which was located in the state of São Paulo and began operating in 1901. In 1960, Brazil had 12 higher schools of agriculture and 8 veterinary schools, but none undertook much research. This situation changed in 1963, when an intensive collaboration began among four Brazilian and four U.S. universities, financially supported by the U.S. Agency for International Development (USAID).

Current Structure of Public Agricultural R&D

The organization of agricultural R&D in Brazil is complex, partly because of the size of the system and the number of agencies involved and partly because of the involvement of both the federal and state governments.[6] Embrapa, which continues to be the central agency, falls under the administration of the Ministry of Agriculture and Food Supply. Although Embrapa was created as a corporation, largely unencumbered by the customary government regulations, its semi-autonomous status has eroded over time, and funding from general government revenues continues to predominate. Embrapa conducts applied research and currently consists of 15 central units, 2 service units, and 37 research centers located throughout the country.[7] Two other federal agencies involved in agricultural R&D are the Executive Commission for Cocoa (CEPLAC), which oversees the Research Center for Cacao (CEPEC), and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA). The latter focuses its research on fisheries, forestry, natural resources, and the environment.

Currently, state government agricultural research agencies operate in 16 of the 26 states. Six states in the northern region (Pará, Amazonas, Acre, Rondônia, Roraima, and Amapá) as well as Piauí in the northeastern region, have no local institutes, foundations, or private firms engaged in agricultural research. In Ceará and Maranhão, the state agencies were closed in 1998–99. In the state of Tocantins, agricultural research is conducted at the Faculty of Agronomy of the University of Tocantins. All 16 states have a single state government research agency, with the exception of São Paulo, which has 6, each with a distinct mandate. São Paulo's agricultural R&D agencies are being reorganized, and plans also exist to make the São Paulo Agency for Agribusiness Technology (APTA), which coordinates the state's agricultural research, an autonomous agency with some degree of independence from the state government, again to create flexible management practices and attract private funding. As of 2003, the future of the state agricultural research agencies was unclear. Only a few state agencies have sufficient resources for effective research, and several agencies that were amalgamated with their respective state agricultural-extension services now appear to focus on extension more than research. Further, state governments are becoming less willing to fund the state institutes because they feel that agricultural research is primarily the federal government's responsibility, through Embrapa. In an effort to overcome the state agencies' financial and operational difficulties, Embrapa is assisting the state agencies in developing new institutional arrangements.

Brazil has a substantial number of universities, with over 100 faculties or schools of agricultural sciences that conduct research. Most of these are federal and

state universities; only a few of the private universities offer training and research in the agricultural sciences (Alves 1992).

We identified five Brazilian nonprofit institutions engaged in agricultural research in the late 1990s. The Cooperative for Sugarcane, Sugar, and Alcohol Producers of the State of São Paulo (COPERSUCAR) is a cooperative of 36 sugar mills located in São Paulo, including a technical center that conducts sugarcane breeding, postharvest research, and technology transfer activities. The Fund for Citrus Plant Protection (FUNDECITRUS) is financed by a tax on citrus production; it monitors citrus health and funds citrus research projects conducted by various Brazilian agencies. It also conducts its own research at its Citrus Research Center (created in 1994) in collaboration with various national and international agricultural organizations (FUNDECITRUS 2001). The Rio Grande Rice Research Institute (IRGA) primarily conducts rice research but also undertakes some research on maize, sorghum, and soybeans. Two other nonprofit institutions conducting agricultural research are the Foundation Center for Wheat Experimentation and Research (FUNDACEP) and the Central Agricultural Cooperative for Technology Development and Economics (COODETEC), which are linked to and financed by producer organizations in Rio Grande do Sul and Paraná, respectively. Both these agencies conduct research on corn, wheat, and soybeans; COODETEC also conducts cotton research.

Brazilian Public Agricultural Research Investments

In 1996, public agricultural research investments totaled $1.3 billion (in 1999 international prices)[8] in a 57-agency sample, employing a total of 4,620 full-time equivalent (fte) agricultural researchers (Table 10.2). The 28-agency sample for higher-education institutions developed by Beintema, Avila, and Pardey (2001) included most of the important agricultural research agencies, but we suspect we missed about one-third of the total fte agricultural researchers working in Brazil's higher-education sector. Scaling up our estimated national totals to account for missing higher-education data brings the total fte agricultural researchers to 4,895 and total spending to $1.4 billion.[9]

In contrast to the situation in some other Latin American countries, such as Mexico, Costa Rica, and Honduras, government agencies in Brazil accounted for the majority of the agricultural research investments and researcher numbers (Beintema and Pardey 2001). In 1996, $1.1 billion of the $1.4 billion total public agricultural R&D spending (adjusted for missing higher-education agencies) was spent by government agencies; Embrapa accounted for 58 percent of the total public agricultural spending, the state agencies for 20 percent.[10]

Table 10.2 Brazil: Composition of public agricultural research expenditures and researchers, 1996

Type of institution	Spending				Researchers			
	Million 1999 reais	Million 1999 international dollars	Share of total (percent)		Full-time equivalents	Share of total (percent)		Number of agencies in sample
			Actual	Adjusted[a]		Actual	Adjusted[a]	
Federal government agencies								
Embrapa	671.0	828.4	61.9	58.4	2,092.0	45.3	42.7	1
CEPEC	20.2	24.9	1.9	1.8	89.0	1.9	1.8	1
State government agencies	231.9	286.3	21.4	20.2	1,762.4	38.1	36.0	22
Nonprofit institutions	31.2	38.5	2.9	2.7	117.0	2.5	2.4	5
Higher-education agencies[a]	129.9	160.3	12.0	16.9	559.2	12.1	17.1	28
Total								
Actual	1,084.2	1,338.5	100		4,619.6	100		57
Adjusted[a]	1,148.2	1,417.5		100	4,895.0		100	

Source: Beintema, Avila, and Pardey 2001.

Notes: See Beintema, Avila, and Pardey 2001 for specific information on agency samples. Embrapa data for 1995 were used as a basis for the calculation to compensate for the spike in Embrapa's 1996 expenditures.

[a]We estimated that our sample included about two-thirds of the fte research staff employed at higher-education agencies; hence we estimated expenditures for these agencies based on average expenditures per researcher for government agencies and nonprofit agencies. These estimates are reflected in the adjusted shares and totals.

The breakdown of fte researchers differs from the institutional structure of agricultural R&D expenditures. In 1996, Embrapa accounted for 43 percent of total fte public agricultural research staff and 58 percent of total spending, while state agencies had 36 percent of the fte researchers and 20 percent of the expenditures. These data reflect Embrapa's generally stronger financial situation compared with the state agencies and the 1996 spike in Embrapa funding resulting from atypical retirement benefits paid out that year.

Trends in Public Investments

Expenditures. Agricultural research spending for a sample of 45 agencies grew substantially in the late 1970s, at an average rate of 9.9 percent per year. Total R&D investments declined slightly during the early 1980s but grew again during the late 1980s and 1990s, at rates of 4.6 and 2.8 percent per year, respectively—well below the rates of the late 1970s (Table 10.3). Embrapa's total expenditures grew faster than those of the state agencies between 1976 and 1996 (4.1 versus 3.1 percent, respectively), peaking in 1996. After adjusting for inflation, Empraba's total spending in 2000 was 13 percent lower than in 1996. Also, spending by the state agencies declined during the 1996–98 period: total spending for a 19-agency sample contracted by 8 percent. No quantitative information on total expenditures was available for the years following 1998, but they appear to have continued to decline.

Researchers. Between 1976 and 1996, the total number of fte researchers employed by the 45 public agricultural R&D agencies in the sample reported here grew at an average rate of 2.3 percent per year (Table 10.4). The institutional distribution of agricultural researchers has changed comparatively little in Brazil since the mid-1970s. By contrast, in other countries in the region (such as Colombia and a number of Central American countries), the higher-education sector and other (often nongovernment) agencies now employ a significantly larger share of total agricultural researchers.[11]

While the institutional distribution of agricultural researchers remained fairly constant, educational levels of researchers have changed substantially since the mid-1970s. In 1996, more than half of the fte researchers in Brazil were trained to the M.Sc. level, and close to one-third held doctoral degrees. These shares are higher than those in other Latin American countries in the same year. For six countries in a ten-country Latin American sample, fewer than 40 percent of the researchers held postgraduate degrees in 1996 (Beintema and Pardey 2001). The 1996 picture for Brazil is very different from two decades earlier, when only a quarter of the researchers (in a 39-agency sample) had postgraduate training (Figure 10.1). Embrapa has invested heavily in research staff training and received considerable

Table 10.3 Brazil: Trends in public agricultural research expenditures, 1976–2000

Period	Government agencies			Nonprofit institutions	Higher-education agencies[a]	Total
	Embrapa	CEPEC	State			
Agencies in sample	1	1	22	4	17	45
Expenditures in constant local currencies (million 1999 reais)						
1976–80	284.3	16.1	158.3	4.2	50.8	513.7
1981–85	382.3	20.4	189.1	6.8	67.7	666.2
1986–90	403.7	21.1	240.4	5.8	65.1	736.1
1991–95	516.1	21.6	257.8	5.8	80.5	881.8
1996	671.0	20.2	231.9	8.2	86.9	1,018.2
1998	566.9	NA	213.6[b]	NA	NA	NA
2000	582.5	NA	NA	NA	NA	NA
Expenditures in constant international dollars (million 1999 international dollars)						
1976–80	351.0	19.9	195.5	5.2	62.7	634.2
1981–85	471.9	25.2	233.4	8.4	83.6	822.5
1986–90	498.3	26.0	296.8	7.2	80.4	908.7
1991–95	637.1	26.6	318.3	7.2	99.4	1,088.6
1996	828.4	24.9	286.3	10.1	107.3	1,257.1
1998	699.9	NA	263.6[b]	NA	NA	NA
2000	719.2	NA	NA	NA	NA	NA
Annual growth rate (percent)[c]						
1976–81	12.6	17.8	4.7	12.9	8.8	9.9
1981–86	–2.9	–5.1	4.1	0.9	–1.2	–0.7
1986–91	8.1	4.6	–1.1	–6.0	3.6	4.6
1991–96	4.8	–3.0	–0.9	12.3	2.0	2.8
1976–96	4.1	1.8	3.1	2.2	3.0	3.6

Source: Beintema, Avila, and Pardey 2001.

Notes: See Beintema, Avila, and Pardey 2001 for specific information on agency samples. Data from 1976 to 1995 are presented as five-year averages. NA indicates data are not available.

[a]Higher-education agency expenditures were estimated using average expenditures per researcher for government agencies and nonprofit institutions.

[b]Data for 6 of the 22 state agencies (accounting for 13 percent of total fte research expenditures at state agencies in 1996) were estimated using the trend from 1996 to 1998 for the 16 agencies for which data were available.

[c]Least-squares growth rates.

support from the Inter-American Development Bank (IDB) and the World Bank for upgrading staff qualifications. Largely because of these extensive investments in human capital development, the total share of Embrapa researchers trained to the postgraduate level increased from 17 percent in 1976, lower than the Brazilian sample average that year, to 93 percent in 1999.[12] However, Embrapa will need to continue investing heavily in human capital to maintain the quality of its research

Table 10.4 Brazil: Trends in numbers of public agricultural researchers, 1976–2001

Trend/ period	Government agencies			Nonprofit institutions	Higher-education agencies	Total
	Embrapa	CEPEC	State[a]			
Agencies in sample	1	1	22	4	17	45
Researchers (fte's)						
1976–80	1,395.2	111.6	1,296.2	38.2	276.1	3,117.2
1981–85	1,610.4	115.2	1,641.5	50.0	315.5	3,732.6
1986–90	1,963.4	135.6	1,785.3	52.2	349.6	4,286.1
1991–95	2,111.8	115.6	1,824.9	48.6	364.2	4,465.1
1996	2,092.0	89.0	1,762.4	57.0	374.3	4,374.6
1998	2,063.0	NA	1,547.5[b]	NA	NA	NA
2001		NA	NA	NA	NA	NA
Annual growth rate (percent)[b]						
1976–81	4.2	4.8	4.5	4.0	3.2	4.3
1981–86	1.6	–0.3	3.0	3.3	1.6	2.2
1986–91	4.5	1.1	0.2	–1.6	1.2	2.2
1991–96	0.4	–6.9	0.5	1.9	1.5	0.3
1976–96	2.8	0.1	2.1	1.5	1.8	2.3

Source: Beintema, Avila, and Pardey 2001.

Notes: See Beintema, Avila, and Pardey 2001 for specific information on agency samples. Data from 1976 to 1995 are presented as five-year averages. NA indicates data are not available.

[a]Data for 6 of the 22 state agencies (accounting for 13 percent of total fte research expenditures at state agencies in 1996) were estimated using the trend from 1996 to 1998 for the 16 agencies for which data were available.

[b]Least-squares growth rates.

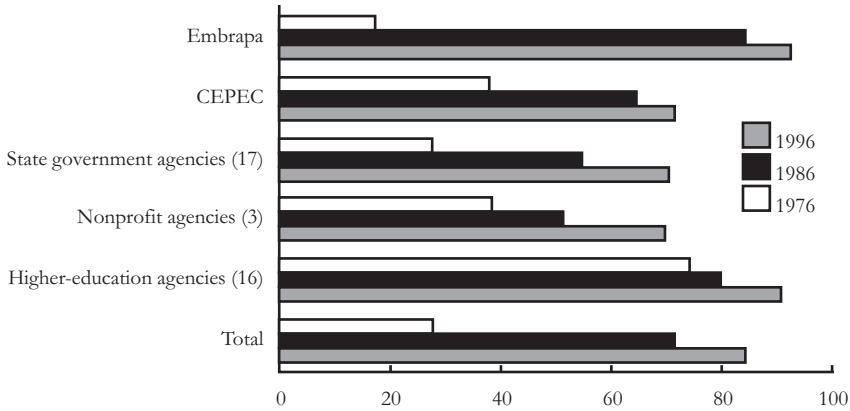
staff, because more than one-third of the 1998 research staff (750 researchers) will retire before 2008 (Embrapa 1999a).

Spending per scientist. Because the growth rate of real research spending was higher than the corresponding rate of growth for the total number of fte researchers, spending per scientist increased by about 50 percent between 1976 and 1996 (Figure 10.2). In general, the trends in spending per scientist showed the same erratic nature as trends in total spending, with two spikes in the early 1980s and 1990s.

Average expenditures per researcher in Brazil were considerably higher than in other Latin American countries (with the exception of Chile). In 1996, spending per scientist in Brazil was $290,000—more than three times the average in Central America, for example (Beintema and Pardey 2001).[13]

Within Brazil there were substantial differences among the various institutional categories. Embrapa's spending per scientist, at $396,000 in 1996, was more than

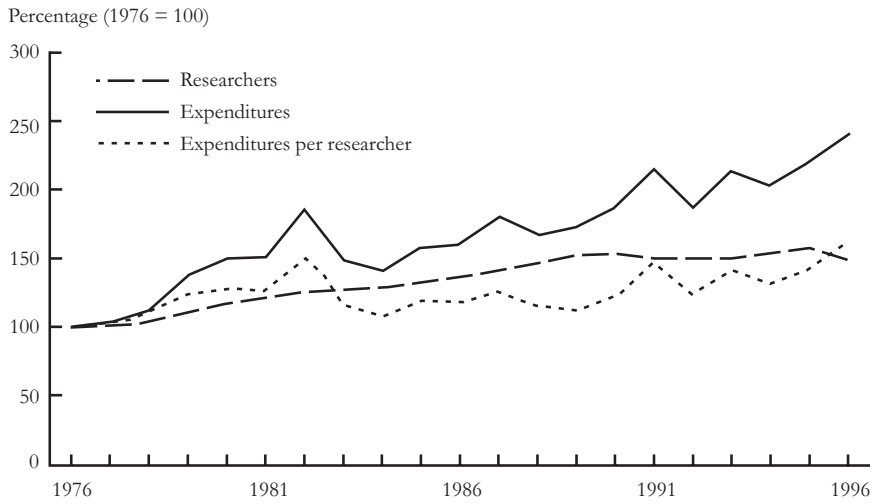
Figure 10.1 Brazil: Postgraduate share of total research staff, by institutional category, 1976–96



Source: Beintema, Avila, and Pardey 2001 (Figure 5a).

Note: Figures in parentheses indicate the number of agencies in each category.

Figure 10.2 Brazil: Agricultural research expenditures, researchers, and expenditures per researcher, 1976–96



Source: Beintema, Avila, and Pardey 2001.

Note: We used the data in Table 10.3, along with other information, to scale up the estimates for the 17 higher-education agencies for which time-series data were available; we adjusted for the fact that many of the significant faculties engaged in agricultural R&D originated only in the 1980s and early 1990s.

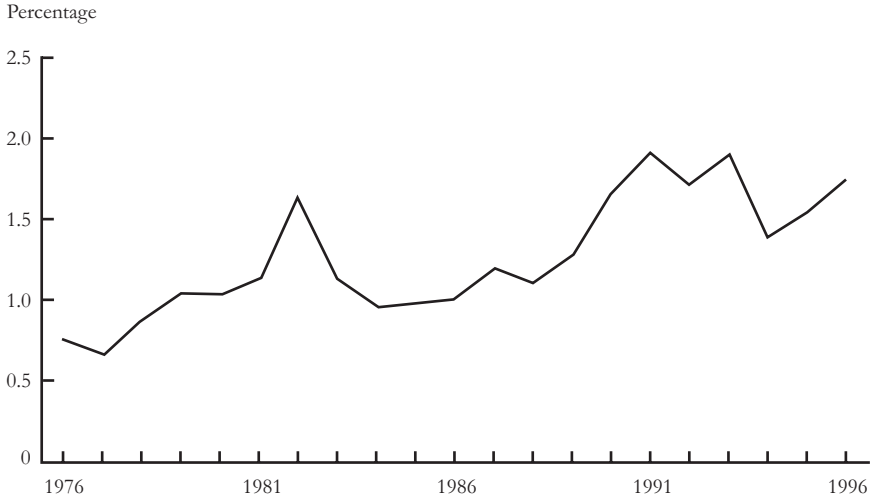
twice the comparable figure for the state government agencies, at $162,000. More recent data for Embrapa and the state agencies show that expenditures per researcher declined with the decline in total expenditures between 1996 and 1998.[14]

Research-Intensity Ratios

Total public spending as a percentage of agricultural output (AgGDP) helps place a country's agricultural R&D spending in an internationally comparable context and normalizes for changes in the size of a country's agricultural sector over time. According to our adjusted estimates, the public-sector intensity ratio more than doubled from 0.8 percent in 1976 to 1.7 percent in 1996. The growth in intensity has been uneven, however, with significant spikes in 1982 and 1991–93 (Figure 10.3). Notably, Brazil's agricultural research intensity in 1996 was considerably higher than those in other countries in the region. The Brazilian ratio is moving closer to the lower end of the range observed for developed countries and is comparable to that of such countries as Ireland, Italy, Portugal, and Spain (Pardey and Beintema 2001).

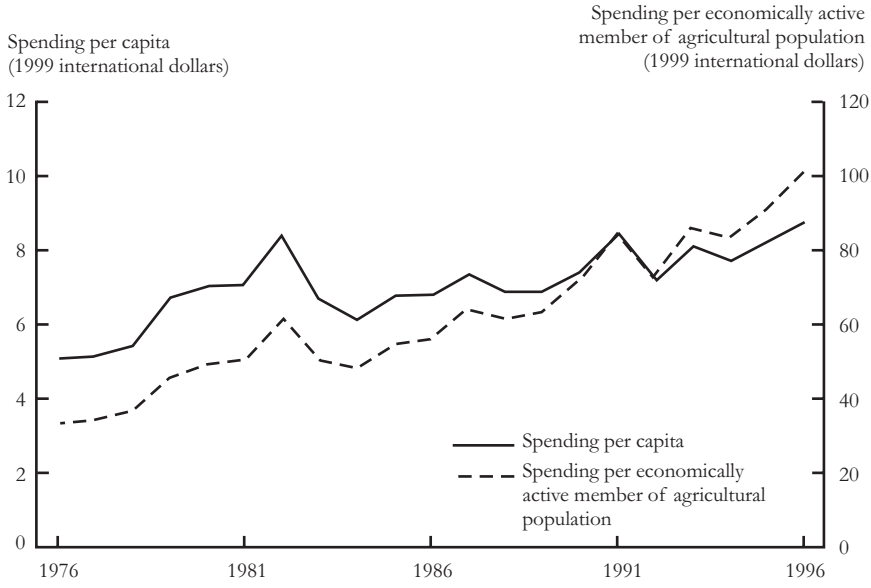
Since 1996, the intensity ratio has no doubt declined, given the drop in spending by Embrapa and the state agencies, which, combined, account for the preponderance of public agricultural R&D expenditures in Brazil. If expenditures by other public agencies (such as CEPEC, the nonprofit institutions, and the higher-

Figure 10.3 Brazil: Public agricultural R&D spending relative to AgGDP, 1976–96



Sources: Expenditure data underlying Figure 10.2; AgGDP from World Bank 2000.

Figure 10.4 Brazil: Spending per capita and per economically active member of agricultural population, 1971–96



Sources: Expenditure data from Table 10.3; population and economically active member of agricultural population from FAO 2005.

education institutions for which we do not have data) remained unchanged after 1996, Brazil's 1998 intensity ratio would have declined to 1.5; however, it was likely lower in reality because, given Brazil's generally poor economic performance in recent years, spending by most public agencies probably contracted.

These trends for agricultural R&D spending per capita and per economically active member of the agricultural population paralleled those for research spending as a percentage of agricultural GDP (Figure 10.4). Agricultural R&D spending per capita (adjusted for expenditures deemed missing from our sample) increased from $4.7 per capita in 1976 to $7.8 in 1996 (at 1999 international prices). Spending per economically active member of the agricultural population increased more than spending per capita, an unsurprising result given the declining proportion of farmers in the total population. Agricultural R&D spending per capita of economically active agricultural population was $101 in 1996, compared with only $33 in 1976 (at 1999 international prices). By comparison, in 1996 Colombia spent $4.2 per capita and $45 per capita of economically active agricultural population

on agricultural R&D, well below the corresponding Brazilian figures (Beintema, Romano, and Pardey 2000).

Private-Sector Involvement

Brazil has an active and growing private sector, providing technologies and technical services mainly concerned with farm inputs (including agrichemicals, animal feeds and breeding services, fertilizers, seeds, veterinary medicines, and machinery) and food processing. There is little specific information available on the local research underpinning these technologies, but the qualitative responses to our surveys, combined with other sources, imply that many of the technologies represent spillins to Brazil from research done elsewhere. Some of the national seed companies conduct some research in Brazil, much of which involves local testing and screening of improved germplasm developed elsewhere. Since the mid-1990s, a considerable number of these national seed companies (especially those marketing corn and soybeans) have been taken over by multinational corporations.

The 11 firms from which we received survey responses employed an estimated total of 88 fte scientists and spent $28 million (Table 10.5). We identified 27 additional firms[15] that probably provide input technologies or technical services to production agriculture or are involved in postharvest (mainly food-processing) activities, but a sizable share of the relevant technologies is developed outside Brazil.[16] We estimate that the 11 private companies in our sample accounted for about half

Table 10.5 Brazil: Private agricultural research spending and researchers, 1996

	Expenditures		
Type of agency	Million 1999 reais	Million 1999 international dollars	Researchers (fte's)
Private enterprises (11-agency sample)			
National	17.8	22.0	70.5
Multinational	4.9	6.0	17.0
Subtotal	22.7	28.0	87.5
Adjusted subtotal[a]	45.4	56.0	175.0
Adjusted subtotal for public agencies	1,193.5	1,473.5	4,895.0
Adjusted subtotal for private enterprises as a percentage of total[b]	3.8	3.8	3.5

Sources: Table 10.1 and Beintema, Avila, and Pardey 2001.

[a]Adjusted based on the estimation that our sample included only about half the fte research staff employed in private enterprises.

[b]Includes public and private agricultural R&D, adjusted for omitted higher-education agencies and private enterprises.

the total agricultural R&D spending and fte researchers working in the private sector in 1996.

After adjusting for these omitted private agencies, we estimate that in 1996 agricultural R&D spending by private firms totaled $56 million, which was 4 percent of the $1.5 billion of total (public and private) spending that year. This figure is considerably higher than the corresponding shares in most other Latin American countries for which we have data (Beintema and Pardey 2001) but less than one-tenth of the average share of 52 percent for developed countries in 1995 (Pardey and Beintema 2001).

Funding for Agricultural Research

Despite the development of some new funding sources and mechanisms, agricultural research in Brazil remains heavily reliant on government sources. Between the mid-1970s and the mid-1990s, funding for agricultural R&D generally increased. Since then, financial support to Embrapa and the state agencies has contracted significantly. Spurred by these declines, Embrapa examined options for a new mechanism to finance the agricultural research conducted by federal and state government agencies. The main proposal under consideration was the creation of a voluntary tax for research and promotion, to be sanctioned by statute and based on the "check-off" (levy) programs used in other countries, such as the United States and Canada. This program, dubbed the voluntary tax for technology development (AGROMAIS), had as one of its objectives to increase the role of the private sector in financing agricultural technology development (Portugal et al. 1999). However, the proposal failed to obtain government backing.

In part, this initiative targeted to agricultural R&D funding was overtaken by a much broader-ranging policy initiative to develop a Brazilian innovation law. The law, which received congressional approval in December 2004, came into force in mid-2005, but, as of early 2006, awaits regulation intended to provide the legal framework to improve the country's capacity to generate and commercialize technology. The law deals directly with incentives to foster cooperative links between public scientific and technological institutions (STIs) and the private sector. It gives STIs more flexibility to negotiate technology licensing agreements and to strike deals with private enterprises for use of public labs. Public researchers will be free to work for other STIs for the time it takes to conclude joint projects, while continuing to receive their regular salaries, and can also request special leave without pay if they opt to become involved with a start-up company to further develop their technologies (Páscoa 2005).

Funding Support at Government Agencies

Embrapa. In nominal terms, direct funding for Embrapa (detailed below) increased from 1986 to 1996, with some marked fluctuations, but total funding has declined in more recent years. In 2000, Embrapa's direct funding was $583 million (in 1999 international dollars), 20 percent lower than the 1996 comparable total (Table 10.6). This decline occurred in all four funding categories but was higher for nongovernment than for government funding. In 2000, 94 percent of Embrapa funding came from government sources, highlighting the agency's continuing dependence on the government.

In addition to Embrapa's line-item funding in the national budget, its direct funding includes grants and contracts with other federal agencies and other institutions, plus license income and revenues from sales of produce, seeds, and so on. Embrapa also receives so-called indirect funds that include donations and payments for publications and events by third parties (as well as scholarship support to researchers not formally employed at Embrapa, such as undergraduate and graduate students or temporary staff). The amount of indirect funding coming to Embrapa increased during the 1990s, but the share remains small overall (3 to 4 percent of total funding).

Over the years, Embrapa has had three loans from the IDB and four from the World Bank.[17] With the exception of the last World Bank loan, these funds have been used to improve Embrapa's infrastructure and train its research staff. The fourth World Bank loan was approved in 1996, and, in a marked departure from previous practice, 60 percent of the total was earmarked for operational expenses disbursed through a competitive funding arrangement (see next section). In 2004, the Brazilian government completed negotiations on a new loan to Embrapa Agrofuturo, which was financed by the IDB and became operational in early 2006.

State government agencies. The state government agencies in our sample depend primarily on contributions from their respective state governments. In 1996, 81 percent of total funding for a sample of 11 agencies came from government—mostly state—contributions, with only a small share of funds provided by the federal government through Embrapa (Beintema, Avila, and Pardey 2001). During the early 1990s, total funding for state agencies declined, and the decline appears to have continued in recent years. As mentioned, two state agencies have closed, and others have been merged with state extension agencies; a few others are bankrupt but lack sufficient funding to reconcile their debt. State government contributions are declining and often are sufficient to cover only salaries and basic operational costs like electricity.

Table 10.6 Brazil: Embrapa's funding sources, 1986, 1991–96, and 2000

Funding source	Total funding (million 1999 reais)				Total funding (million 1999 international dollars)				Percentage of direct funding			
	1986	1991–95	1996	2000	1986	1991–95	1996	2000	1986	1991–95	1996	2000
Direct funding												
Government	340.7	529.3	591.3	547.6	420.6	653.4	730.0	676.1	78.3	88.1	81.2	94.0
Donor contributions	34.6	26.4	56.6	6.0	42.7	32.6	69.8	7.4	7.9	4.4	7.8	1.0
Research contracts	3.9	2.7	17.3	—	4.8	3.3	21.3	—	0.9	0.4	2.4	—
Sales	56.1	42.5	62.9	28.9	69.3	52.4	77.7	35.7	12.9	7.1	8.6	5.0
Subtotal	435.3	600.9	728.0	582.5	537.4	741.8	898.8	719.2	100	100	100	100
Indirect funding	—	—	18.6	NA	—	—	23.0	NA				
Total	435.3	600.9	746.6	NA	537.4	741.8	921.7	NA				

Source: Beintema, Avila, and Pardey 2001.

Notes: See Beintema, Avila, and Pardey 2001 for specific information on agency samples. A dash indicates nonexistent; NA indicates not available.

Table 10.7 Brazil: IAC's funding sources, 1995–98

Funding source	Total funding (million 1999 reais)				Total funding (million 1999 international dollars)				Percentage of total funding			
	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998
Direct funding												
State budget	21.9	25.0	26.7	21.8	27.0	30.8	32.9	26.9	80.4	72.0	78.0	80.0
State fund	1.1	1.3	0.6	0.8	1.3	1.6	0.8	1.0	4.0	3.7	1.8	2.9
Subtotal	23.0	26.3	27.3	22.6	28.3	32.4	33.7	27.9	84.4	75.7	79.8	82.9
Other funding												
FUNDAG	1.2	1.6	2.4	0.9	1.5	2.0	3.0	1.1	4.5	4.6	7.1	3.4
FINEP	1.0	0.3	1.1	0.5	1.2	0.4	1.4	0.6	3.5	1.0	3.2	1.8
FAPESP	2.0	6.3	3.3	1.8	2.5	7.8	4.1	2.2	7.4	18.3	9.6	6.5
FUNDEPAG	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4	0.1	0.0	0.1	1.1
Embrapa	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.4	0.1	0.1
PRONAF	—	—	—	0.6	—	—	—	0.8	—	—	—	2.4
FUNCAFE	—	—	—	0.5	—	—	—	0.6	—	—	—	1.8
Subtotal	4.2	8.4	6.9	4.6	5.2	10.4	8.5	5.7	15.6	24.3	20.2	17.1
Total	27.2	34.7	34.2	27.2	33.6	42.8	42.2	33.6	100	100	100	100

Source: Beintema, Avila, and Pardey 2001.

Notes: FAPESP (São Paulo Research Support Foundation) is a state foundation; FUNCAFE (Fund for Protection of the Coffee Economy), PRONAF (National Program for Strengthening Family Agriculture), and FINEP (Financing Agency for Studies and Projects) are federal funding programs. FUNDAG (Foundation for Agricultural Research Support) and FUNDEPAG (Foundation for Agricultural Development and Research) are private foundations. A dash indicates not applicable.

In recent years, state agencies have become increasingly reliant on funding from nongovernment sources. For example, between 1995 and 1998, IAC received an average of 80 percent of its funding from the state government (77 percent directly and 3 percent by way of a special fund). The remaining 20 percent came from various public and private foundations (Table 10.7). These funds were used mainly for operational costs but also covered some expenses made for capital improvement and salaries paid to additional research staff (often hired as consultants).

Competitive Funding Mechanisms

In many developing countries, competitive funding mechanisms have been introduced as one of a number of new instruments for disbursing research resources.[18] This has been the case for a number of Latin American countries where diminishing public support for agricultural research, beginning in the 1980s, led to various institutional and policy reforms in the funding of research. Competitive funding mechanisms have gained favor among some policymakers, donors, and even researchers. They are seen as a means of redirecting research priorities, increasing the role of the private and academic sectors in the performance of research, and, perhaps, forging new links among government, academic, and private research agencies. The use of competitive funding has advantages and disadvantages over block grants. Competitive funding mechanisms involve relatively high transaction costs (such as writing and screening proposals) and rent-seeking costs (such as lobbying for support), but could lower the social costs arising from the misallocation of funds. Further, the use of competitive funds tends to increase flexibility, but it often forces a short-term, applied research orientation at the expense of more basic, longer-term research (Echeverría, Trigo, and Byerlee 1996; Echeverría 1998; Alston and Pardey 1999).

Competitive funding mechanisms have existed in Brazil for some time. Since its inception, Embrapa has disbursed resources to finance projects through a competitive national program open to Embrapa's research centers and all other national public research agencies, including state agencies and universities. This program funds 500 to 600 projects each year. About 95 percent of the funded projects are conducted by Embrapa scientists, although state and higher-education agencies had a larger presence in the program during the 1970s and 1980s. The new IDB loan, which became operational in early 2006, will continue the competitive fund scheme under much the same rules established as part of an earlier World Bank loan (see below), but only Embrapa scientists will be eligible. This change was mandated by the fact that only half the amount proposed ($60 million, not the $120 million sought) was approved.

Agricultural Technology Development Project (PRODETAB). A World Bank loan of US$60 million was approved in 1996 to support the Agricultural Technology Development Project (PRODETAB) over five years. The funds were matched by an additional US$60 million from the Brazilian government, Embrapa, and various other public and private agricultural R&D agencies. PRODETAB has three components. The largest share supports a competitive funding program (60 percent); 37 percent is earmarked for institutional development and training activities at Embrapa and state government agencies (particularly in the historically weak north and northeast regions), plus the development of international research linkages; and 3 percent supports the administration, monitoring, and evaluation of PRODETAB itself (Reifschneider and Lele 1998).

The primary objective of PRODETAB is to integrate and diversify the national agricultural R&D system through collaborative research and technology transfer, thereby promoting private-sector participation. Five priority areas were established: biotechnology, natural resource management, small-farm development, agribusiness, and strategic research on high-priority issues not already undertaken by Embrapa's programs (Lele 1998; Lele and Anderson 1999).[19]

By the end of 2000, 4 calls for proposals had been made—1 in 1997, 2 in 1998, and 1 in 1999—resulting in 392 proposal submissions, of which 46 were approved (12 percent). The total approved funding from the four submission rounds was $21.8 million in 1999 international prices (Embrapa 1999b).

PRODETAB represents a new approach to disbursing Embrapa's research funds, and funds in Brazil more generally, but block funding still predominates. Annual disbursals from the World Bank component of PRODETAB averaged $12 million over the five years of the project, just 2 percent of Embrapa's annual budget and around 1 percent of Brazil's total agricultural R&D expenditures. The PRODETAB funds made available to Embrapa during the period 1997–99 represented only 1 percent of the agency's total funding for that period.

Conclusion

At 1.5 billion (1999 international dollars) in 1996, Brazil accounts for about half the total agricultural R&D investments made in Latin America and the Caribbean (Pardey and Beintema 2001) and employs the third largest number of agricultural scientists (about 5,000 ftes). Agricultural R&D in Brazil is organizationally complex, encompassing numerous federal and state government agencies, higher-education institutions, nonprofit institutions, and private enterprises. Nonetheless, the public sector is still the predominant agricultural R&D provider in Brazil; by

our estimates, government agencies accounted for 79 percent of the country's agricultural R&D expenditures in 1996. An increasing amount of agricultural technology appears to be provided by the private sector, but comparatively few of these technologies are the result of private research conducted in Brazil.

Among the government agencies, Embrapa dominates, accounting for 72 percent of government agricultural R&D spending. Spending per scientist for the state agencies is about half the comparable Embrapa figure. Both Embrapa and the state government agencies still rely on government sources of support. In 1996, government sources provided about 80 percent of the funds disbursed to Embrapa and the state research agencies. Funding for Brazilian agricultural R&D tends to rise and fall with the general state of the economy. Although funding has increased overall since the mid-1970s, the economic downturns of the early 1980s and the late 1990s saw a commensurate cutback in funding for agricultural R&D.

The intensity of investment in agricultural R&D in Brazil is comparable to that of developed countries, albeit at the lower end of the range. In 1996, Brazil invested $1.70 for every $100 of agricultural output, more than double the 1976 figure and well above the intensity of investment of most other Latin American countries. How agricultural R&D in Brazil fares in the future will depend on continuing government commitment, in the form of policies to encourage the international flows of technologies and technical know-how, sustained support for building and maintaining the country's scientific expertise, fostering economic conditions and protection for intellectual property rights that encourage private participation in R&D, and, perhaps most critically, continuing to fund the basic and strategic science that underpins the private roles in technology generation and transfer.

Abbreviations and Acronyms

AGROMAIS	Taxa voluntária de desenvolvimento tecnológico (Voluntary tax for technology development)
APTA	Agência Paulista de Tecnologia dos Agronegócios (São Paulo Agency for Agribusiness Technology)
CEPEC	Centro de Pesquisa do Cacau (Research Center for Cacao)
CEPLAC	Comissão Executiva do Plano da Lavoura Cacaueira (Executive Commission for Cocoa)
COODETEC	Cooperativa Central Agropecuária de Desenvolvimento Tecnológico e Econômico Ltda (Central Agricultural Cooperative for Technology Development and Economics)

COPERSUCAR	Cooperative dos Produtores de Cana, Açúcar e Alcool do Estado de São Paulo Ltda (Cooperative for Sugarcane, Sugar, and Alcohol Producers of the State of São Paulo)
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
FUNDACEP	Fundação Centro de Experimentação e Pesquisa Fecotrigo (Foundation Center for Wheat Experimentation and Research)
FUNDECITRUS	Fundo de Defesa da Citricultura (Fund for Citrus Plant Protection)
IAC	Agronomic Institute of Campinas
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources)
IRGA	Instituto Rio-Grandense do Arroz (Rio Grande Rice Research Institute)
ISNAR	International Service for National Agricultural Research
PROCENSUL	Projeto Fortalecimento da Pesquisa e Difusão de Tecnologia na Região Centro-Sul (Project for Strengthening Research and Technology Transfer in the Center-South Region)
PRODETAB	Projeto de Apoio ao Desenvolvimento de Tecnologia Agropecuária para o Brasil (Agricultural Technology Development Project)
PROMOAGRO	Programa de Madoernização Tecnológica da Agropecuária da Região Centro-Sul do Brazil (Program for Modernization of Agricultural Technology in the Center-South Region of Brazil)

Notes

This chapter is adapted from *Agricultural R&D in Brazil: Policy, Investments, and Institutional Profile,* a report prepared by the authors as part of the Agricultural Science and Technology Indicators (ASTI) initiative.

1. Public agricultural R&D agencies include government agencies, higher-education institutions, and nonprofit institutions. For additional information and other definitions used in this chapter, see the ASTI website at http://www.asti.cgiar.org.

2. Brazil has the third-largest total public agricultural R&D investment among less-developed countries, after China and India. Together, these three countries accounted for 44 percent of total

agricultural research investments in the developing world in the mid-1990s (Pardey and Beintema 2001).

3. Five imperial research institutes were established in total, but only these two became operational.

4. IAC was an exception in the developing world, as most (if not all) of the other research centers created around that time were established by colonial powers.

5. This state government has had a long history of involvement in agricultural R&D. It created the Biology Institute (still in operation) in 1927.

6. See Beintema, Avila, and Pardey 2001 (Appendix B) for an institutional summary of Brazilian agricultural research agencies.

7. There are 13 ecoregional, 15 commodity, and 9 thematic centers.

8. The financial data in this chapter were converted to 1999 international dollars by first deflating funds compiled in current local-currency units, using a Brazilian GDP deflator with the base year 1993, and then converting to U.S. dollars using a 1999 purchasing power parity (PPP) index from World Bank 2000.

9. Compiling expenditure data for higher-education institutions proved difficult. The minimal data obtained often indicated direct expenditures—such as the operational costs or project funds received from external sources—rather than a comprehensive accounting of all costs, including salaries, rent, and utilities, appropriately prorated to reflect the shares of faculty time spent on research. To redress these problems, an estimate of total expenditures for the higher-education sector was calculated using the average expenditures per researcher for government agencies and nonprofit institutions, scaled by the number of fte researchers employed by the higher-education agencies in our sample.

10. Data for 1996 are not representative of Embrapa's spending pattern at that time because of the extraordinary costs of an early-retirement scheme made available to Embrapa staff that year. Regardless, these one-off costs ($25 million reais) represent only 1 percent of Embrapa's share of total Brazilian expenditures in 1996.

11. Recall that we have less than complete coverage of higher-education institutions, though this lacuna is unlikely to affect information on the institutional distribution of Brazilian agricultural researchers.

12. In 1998, a total of 2,077 Embrapa researchers had completed M.Sc. or Ph.D. studies (Embrapa 1999a), but in recent years the number of Embrapa researchers receiving postgraduate training has decreased. These trends reflect the high proportion of Embrapa researchers who have earned postgraduate degrees while employed and of new hires already holding higher degrees.

13. This average includes four of the six Central American countries: Costa Rica, Guatemala, Honduras, and Panama.

14. This decline in spending per scientist was for Embrapa as a whole. Spending per scientist varied considerably among the various Embrapa centers. In general, centers with comparatively high 1996 spending ratios experienced larger declines than those with lower initial ratios, so that spending-per-scientist ratios became more uniform across Embrapa centers.

15. See Beintema, Avila, and Pardey 2001 (Appendix B).

16. Roseboom (1999) supports our own impressions that comparatively little private food-processing and agricultural-machinery research takes place in Brazil and that much of the agrochemical research conducted by multinational companies is done elsewhere.

17. The three IDB loans were parts 1 and 2 of the Project for Strengthening Research and Technology Transfer in the Center-South Region (PROCENSUL), at US$66.4 and $67.8 million,

and the Program for Modernization of Agricultural Technology in the Center-South Region of Brazil (PROMOAGRO), at US$77.8 million. The four World Bank loans are known as the Agricultural Research Projects 1, 2, and 3, at US$40, 60 and 42 million, respectively, and PRODETAB at US$60 million.

18. For more discussion on alternative funding options, see Echeverría 1998 and Alston and Pardey 1999.

19. Beintema, Avila, and Pardey (2001) give a more detailed description of the PRODETAB competitive fund.

References

Alston, J. M., and P. G. Pardey. 1999. The economies of agricultural R&D policies. Chapter 2 in *Paying for agricultural productivity,* ed. J. M. Alston, P. G. Pardey, and V. H. Smith. Baltimore: Johns Hopkins University Press.

Alves, R. E. A. 1992. Getting beyond the "national institute model" for agricultural research in Latin America: Case study one, agricultural research in Brazil. World Bank, Washington, D.C. Mimeo.

Beintema, N. M., and P. G. Pardey. 2001. Recent developments in the conduct of Latin American agricultural research. Paper prepared for the International Conference on Agricultural Science and Technology, Beijing, November 7–9.

Beintema, N. M., A. F. D. Avila, and P. G. Pardey. 2001. *Agricultural R&D in Brazil: Policy, investments, and institutional profile.* Washington, D.C.: International Food Policy Research Institute, Embrapa, and FONTAGRO.

Beintema, N. M., L. Romano, and P. G. Pardey. 2000. *Agricultural R&D in Colombia: Policy, investments, and institutional profile.* Washington, D.C.: International Food Policy Research Institute and FONTAGRO.

Echeverría, R. G. 1998. *Will competitive funding improve the performance of agricultural research?* Discussion Paper No. 98-26. The Hague: International Service for National Agricultural Research.

Echeverría, R. G., E. J. Trigo, and D. Byerlee. 1996. *Institutional change and effective financing of agricultural research in Latin America.* Technical Paper No. 330. Washington, D.C.: World Bank.

EIU (The Economist Intelligence Unit). 1998. *Country profile 1998–99: Brazil.* London: EIU.

Embrapa (Empresa Brasileira de Pesquisa Agropecuária). 1999a. *Annual report 1998.* Brasilia: Embrapa.

———. 1999b. PRODETAB data tables. Embrapa, Brasilia. Computer diskette.

FAO (Food and Agriculture Organization of the United Nations). 2005. FAOSTAT database. http://faostat.fao.org/default.htm. Accessed September 2005.

FUNDECITRUS (Fundo de Defesa da Citricultura). 2001. FUNDECITRUS: Fund for citrus plant protection. http://www.fundecitrus.com.br/indiceus.html. Accessed May 17, 2001.

IBGE (Instituto Brasileiro de Geografia e Estatística). 1999. *Brasil en números / Brazil in figures.* Rio de Janeiro: IBGE.

Lele, U. 1998. Building regional cooperation from the bottom up and top down: The case of Southern Cone countries. In *Guidelines for designing new organization and funding ways for agricultural and agroindustrial innovation systems in the Southern Cone,* ed. IICA (Instituto Interamericano de Cooperación para la Agricultura). Montevideo: IICA.

Lele, U., and J. R. Anderson. 1999. Brazil agricultural technology development project aide-memoire. World Bank, Washington, D.C. Mimeo.

Pardey, P. G., and N. M. Beintema. 2001. *Slow magic: Agricultural R&D a century after Mendel.* IFPRI Food Policy Report. Washington, D.C.: International Food Policy Research Institute.

Páscoa, M. B. A. 2005. In search of an innovative environment: The new Brazilian innovation law. http://www.wipo.int/sme/en/documents/brazil_innovation.htm. Accessed August 8, 2005.

Portugal, A. D., F. J. B. Reifschneider, E. Contini, and A. B. de Oliveira. 1999. *Taxa Voluntária de Desenvolvimento Tecnológico (AGROMAIS): Um mecanismo inovador de financiamento para a pesquisa, desenvolvimento e promoção do agronegócio.* Brasilia: Instituto Teotônio Vilela.

Reifschneider, F. J. B., and U. Lele. 1998. Making competitive grants programs of the national agricultural research systems work: Learning from the Brazilian experience. Paper prepared for the workshop on PRODETAB and Embrapa Planning, Evaluation and Management Systems, Brasilia, May 24.

Roseboom, J. 1999. *Sources of technological innovation in Brazilian agriculture.* ISNAR Discussion Paper No. 99-12. The Hague: International Service for National Agricultural Research.

World Bank. 2000. *World development indicators 2000.* Washington, D.C. CD-ROM.

———. *World development indicators 2005.* Washington, D.C. CD-ROM.