

CHILE

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Quantitative data are important in measuring, monitoring, and benchmarking the inputs, outputs, and performance of agricultural science and technology (S&T) systems. They are an indispensable tool when it comes to assessing the contribution of agricultural S&T to agricultural growth and, more generally, economic growth. S&T indicators assist research managers and policymakers in policy formulation and decisionmaking on strategic planning, priority setting, monitoring, and evaluation. They also provide information to government and other institutions (such as policy research institutes, universities, and the private sector) involved in the public debate on the state of agricultural S&T at the national, regional, and international levels. This brief reviews the major investment, capacity, and institutional trends in public agricultural research in Chile since 1981, using data collected under the Agricultural Science and Technology Indicators (ASTI) initiative conducted by the International Food Policy Research Institute (IFPRI) and the Institute for Agricultural Research, Chile (INIA) in 2007–08.¹ It provides important updates on trends in Chile's public agricultural research collected by the ASTI initiative during the mid-1990s.

INTRODUCTION

Chile, a long, narrow strip of land with a length of 4,337 kilometers (2,880 miles), stretches from the world's driest desert in the north to Cape Horn in the south. Because of its unusual shape and location, Chile's climate is extremely varied and its natural resources are abundant and diverse, with mineral deposits in the north and central zones, crops, livestock, and forestry in the central and southern zones, and fisheries all along Chile's extensive coastline and rivers. Mining—especially copper mining—is the country's principal economic sector, the state-owned CODELCO being the world's largest copper-producing company. Although agriculture, forestry, and fisheries accounted for a combined share of only 5 percent of the country's GDP in 2006, this

Table 1—Composition of public agricultural research expenditures and research staff, 2006

Type of agency	Total spending		Total research staff (fte's)	Share		Agencies in sample ^a (number)
	2005 Chilean pesos	2005 (PPP) international dollars		Spending (percent)	Research staff	
INIA	15,653.9 (millions)	46.9	279.0	47.8	40.4	1
Other government ^b	8,005.2	24.0	187.1	24.5	27.1	6
Nonprofit agencies ^c	409.5	1.2	22.0	1.3	3.2	2
Higher education ^d	8,652.0	25.9	202.2	26.4	29.3	18
Total	32,720.6	98.1	690.3	100	100	27

Sources: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08) and a number of agency websites.

^a See note 2 for a list of the 27 agencies included in this sample.

^b Staff at the other government agencies spent between 10 and 100 percent of their time on research, leading to 187.1 fte researchers.

^c Staff at the nonprofit agencies spent between 25 and 50 percent of their time on research, leading to 22.0 fte researchers. Expenditures for CAD in 2006 are estimates based on the agency's expenditures in 2005.

^d Staff at the higher education agencies spent between 8 and 40 percent of their time on research, leading to 202.2 fte researchers. Expenditures for the higher education agencies are estimates based on average spending per researcher at the government agencies.

KEY TRENDS

- Agricultural R&D staff numbers have risen gradually since 1981, reaching close to 700 ftes in 2006.
- Expenditures in agricultural R&D developed more erratically but have contracted since the late 1990s, reaching \$98 million (in 2005 constant prices) in 2006, largely the result of reduced spending by INIA.
- Average degree levels of Chilean agricultural R&D staff have improved markedly since the early 1990s, and the country's researchers are among the region's most highly qualified.
- The national government funds the lion's share of agricultural R&D in Chile, either through general appropriations or through competitive funds.
- Chile's private sector is involved in limited agricultural R&D, although it plays a key role in competitively funded projects.

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) initiative comprises a network of national, regional, and international agricultural R&D agencies and is managed by the International Service for National Agricultural Research (ISNAR) division of the International Food Policy Research Institute (IFPRI). The ASTI initiative compiles, processes, and makes available internationally comparable data on institutional developments and investments in public and private agricultural R&D worldwide, and analyses and reports on these trends in the form of occasional policy digests for research policy formulation and priority setting purposes.

Funding for the ASTI initiative's activities in Latin America was provided by the Inter-American Development Bank (IDB), the World Bank via the Consultative Group on International Agricultural Research (CGIAR), and the International Food Policy Research Institute (IFPRI).

crops, livestock, and forestry in the central share would reach 10 percent if the food and beverage manufacturing industry were factored in (Central Bank of Chile 2008). Over the past two decades, agriculture has become increasingly diversified and agricultural production and exports have skyrocketed. Chile's principal crops in terms of production value include fruits, vegetables, cereals, fodder, sugar beets, and potatoes. Much of the fruit is exported to North America and Europe during the northern hemisphere's winter months. Chile also produces and exports large quantities of wine. Sixteen percent of Chile's total land area is classed as permanent grazing ground; forests cover 11 percent, mainly in the southern region; and forest products (mainly timber) are an important export sector. The country's fisheries sector is also of major economic importance. Salmon and trout production are the principal components of this sector.

Over the past 20 years, the Chilean economy has grown more rapidly than any other economy in Latin America (World Bank 2008b). Real per capita incomes have more than doubled since 1990, and with a GDP per capita of about US\$11,000, Chile now ranks among the upper middle income countries.

SCIENCE AND TECHNOLOGY POLICY

Chile's total gross (agricultural and nonagricultural) research and development (R&D) expenditures as a percentage of GDP reached 0.68 percent in 2004, which is higher than the corresponding ratio for many other South American countries, such as Argentina (0.44), Peru (0.16), and Uruguay (0.26), but lower than Brazil's (0.83) and developed countries such as the United States (2.72) and Japan (3.07) (RICYT 2008; MASTIC 2004). Three-quarters of Chile's R&D expenditures are made by the country's public sector and roughly 7 percent by foreign direct investors.

While Chile's social development and general economic

indicators are on a par with the developed world, the country is still lagging behind more developed economies in terms of innovation. In key areas, such as R&D spending, private-sector involvement in R&D, and patent applications, Chile is far behind Organisation of Economic Cooperation and Development (OECD) countries (Holm-Nielsen and Agapitova 2002). The 2007 World Competitiveness Report places Chile in a middle position among 53 countries but near the bottom with regard to R&D spending and patenting (IMD 2007). Nevertheless, Chile outperforms its Latin American neighbors in many key indicator fields and the country has made considerable efforts in basic science development and educational infrastructure in recent years. The recent boost in fruit and wine production and the success of this sector in the international market prove the ability of Chilean producers to implement the latest technological innovations in the production system and to compete in a global market. A recent report of the OECD stated that Chile needs to invest more in R&D, improve its education system, promote public-private partnerships, and foster business-sector innovation—notably among small and medium-sized firms—in order to sustain economic growth (OECD 2007). The Chilean government is fully aware of its weaknesses and has taken various steps toward achieving these goals, including the creation of the National Council on Innovation for Competitiveness (CNIC) in 2005. Chile has a variety of policies, programs, and policy instruments dealing with scientific research, technological development and innovation, and technology dissemination. The National Commission of Scientific and Technological Research (CONICYT) and the Presidential Advisory Commission on Scientific Matters are the principal government bodies responsible for the development of public S&T policies and distribution of funds. In recent years, a third body, the Chilean Agency for Economic Development (CORFO), has also played an increasingly important role both in the development of a

A Short History of Public Agricultural Research in Chile

Agricultural research in Chile began in 1881 when the National Agricultural Society, a private institution, created its first experimental station. Its mandate was to test and introduce several crops in Chile. For the next 50 years, the private sector controlled research and extension, through an association of big landowners. Public agriculture research started in 1930 when the Ministry of Agriculture created the Department of Genetics and Phyto-genetics, renamed the Department of Agricultural Research in 1948. This department focused mainly on the introduction, selection, and production of improved seeds, as well as on studies related to soil, fertilization, and irrigation. By the 1950s, the public sector was already dominating Chilean agricultural research. This was in great part due to aid from the United States government and the Rockefeller Foundation, both of which had invested heavily in training and education of agricultural researchers in the public sector in previous years.

The hallmark of agricultural research in Chile came in 1964 with the creation of INIA. INIA—a semi-autonomous and decentralized government agency—was created by the Agricultural Development Institute (INDAP) of the Ministry of Agriculture, the Chilean Economic Development Agency (CORFO), the University of Chile, the Catholic University of Chile, and Concepción University. In 1986, after previous revisions (in 1968, 1972, and 1980) INIA's statutes were amended. INIA's new mandate included three principal guidelines: to help increase agricultural production in Chile through the adaptation and transfer of technology; to support processes of industrial transformation or incorporation of added value to agricultural products through research, studies, and services; and to improve the country's nutritional indicators through actions that improve the use of resources coming from agriculture.

The presence of higher education agencies in Chilean agricultural research dates back to the 1950s when state-financed research programs were launched at the University of Chile, the Catholic University of Temuco, and the Austral University of Chile. In the 1960s and 1970s, decisions on research focus and funding at university faculties were largely taken by centralized Research Commissions, which were in charge of approving research projects elaborated by staff. Up until the 1980s, universities focused mostly on basic research that lacked focus on particular agricultural issues; research in those years still encompassed a very wide spectrum of S&T themes. In the late 1980s and 1990s, an increasing share of university-led research was financed by competitive funds. This led to a switch from basic to more applied research carried out by universities, as funds were increasingly provided to specific areas.

Source: Castelo Magalhães, Beintema, and Martinez (2002)

series of competitive funds and in the reformulation of government thinking with respect to the financing of public-sector technological institutes. The coexistence of three separate bodies charged with S&T policy formulation and financing, with partly overlapping mandates, can sometimes bring confusion. Therefore, some are calling for an effective single national institute responsible for S&T policy.

Since the early 1990s, the Chilean government has become increasingly aware of the importance of technological progress for the future development of the country and its competitiveness in the world market. This has resulted in a variety of programs that aim to advance S&T in the country, including the Science and Technology Program (1992–95), the Technology Innovation Program (1996–2000), the Program for the Promotion of Productivity by the Technical Cooperation Service (SERCOTEC), and the Millennium Science Initiative Project (1999–2002), as well as the establishment of various competitive funds for S&T, which will be discussed later. Mandated by the Chilean President, CNIC was established in November 2005 and is charged with laying the foundations of a national innovation strategy. CNIC even stipulated that by 2020, Chile is to be a knowledge-based economy spending 2.5 percent of its GDP on S&T. Moreover, the 2005 approval of the law known as Royalty II, which aims to allocate additional resources to S&T development with a special emphasis on competitiveness and innovation, has also had an important impact on Chilean S&T. This law identifies and defines the relationship and mutual dependence and interaction between science, technology, and innovation and calls for increased S&T expenditures (OECD 2007).

INSTITUTIONAL DEVELOPMENTS IN AGRICULTURAL R&D

Twenty-seven agencies were involved in public agricultural research in Chile in 2006.² Combined, these agencies employed close to 700 full-time equivalent (fte) researchers and spent nearly 33 billion Chilean pesos on agricultural R&D (in 2005 constant prices), the equivalent of 98 million PPP dollars in 2005 constant prices (Table 1).³ The Institute for Agricultural Research (INIA) is by far the largest agency involved in agricultural R&D in Chile.⁴ In 2006, it accounted for 40 percent of the country's agricultural researchers and nearly half of agricultural R&D spending. INIA was established in 1964 through the amalgamation of several experiment stations under the Ministry of Agriculture (MINAGRI) (see *A Short History of Public Agricultural Research* on page 2). INIA is a private, nonprofit corporation under MINAGRI and it conducts research with respect to the production, utilization, and processing of crops and livestock.⁵ INIA is headquartered in Santiago de Chile and operates ten regional research centers, called CRIs (for its acronym in Spanish), ranging from Region IV in the north to Region XII in the south.⁶ INIA is governed by a so-called National Council headed by MINAGRI and consists of representatives from public- and private-sector organizations involved in the productive food chain. Each CRI is managed by a regional director and governed by a regional board consisting of local public and private organizations that see that regional research needs are fulfilled by the CRI. Specialty groups have also been set up by each of the CRIs to complement the work carried out in the regions, which include researchers dealing

with specific problems requiring a national outlook (INIA 2008). In 2006, INIA employed 279 fte researchers.

The Valparaíso-headquartered Fisheries Development Institute (IFOP), under CORFO has been charged with fishery research in Chile since 1965. Its main objective is to carry out scientific and technological research on the exploitation of fishery resources and fish stock assessment in Chile's waters. It is also charged with creating methods and technologies for the country's fisheries industry and to develop new systems in aquaculture. IFOP had 107 active fte researchers in 2006.

Since its establishment in 1965, the Forestry Institute (INFOR) has played a central role in the country's forestry development through substantive input in matters relating to the cultivation, harvesting, and utilization of forest resources. INFOR is closely linked to CORFO and MINAGRI, and it conducts extensive research related to wood products, including economic and market studies. The institute is headquartered in Santiago de Chile and employs 57 fte scientists, either at its headquarters or spread among five regional centers (between Regions IV and XI).

Fundación Chile was created in 1976 as a unique platform for interaction among the Chilean government, the private sector, and the academic community.⁷ The foundation performs a strategic role in the generation of innovative products and processes for key sectors of Chile's economy. It is active in the agroindustrial, marine, and forestry sectors and employed 14 fte scientists in 2006, mostly focusing on livestock, wheat, and rice research. Though Fundación Chile is not a government agency in the strict sense of the word, it is considered to be one for the purposes of this study. The remaining three government agencies—the Information Center for Natural Resources (CIREN), the Mining and Metallurgical Research Center (CIMM), and the National Center for the Environment (CENMA)—each employed five or fewer agricultural researchers in 2006.

Two nonprofit agencies were identified as being involved in agricultural R&D in Chile: the Fruit Development Foundation (FDF) and the Agricultural Development Corporation (CAD). FDF is a private nonprofit agency founded in 1992 by a group of national and multinational fruit-exporting companies and producers of fresh fruit to develop joint R&D projects. FDF is charged with the promotion, development, and articulation of scientific and technological research related to fruits, vegetables, and other plants. In 2006, 18 fte agricultural researchers were active at FDF. CAD, headquartered in Santiago, employed five fte scientists in 2006, largely involved in grape and pistachio research.

Although Chile's universities are mainly involved in education, they are also the principal sites of basic (as opposed to applied) agricultural research in the country. A total of 18 university faculties are involved in agricultural R&D in Chile. Combined, they employed more than 200 fte scientists or approximately one-third of the country's agricultural R&D capacity. The principal universities in the agricultural field are the Catholic University of Temuco (42 fte agricultural researchers in 2006), the University of Chile (40 ftes), Concepción University (40 ftes), Pontificia Catholic University of Chile (23 ftes), and Austral University of Chile (17 ftes). The remaining nine university faculties each employed 10 fte researchers or fewer.

Agricultural research takes a prominent position at the Catholic University of Temuco (Region X). It takes place within the university's Faculty of Natural Resources, which operates five separate "*escuelas*": the School of Biological and Chemical Sciences, the School of Aquaculture, the School of Agriculture, the School of Forest Sciences, and the School of Veterinary Medicine (Catholic University of Temuco 2008). The university is well known for its natural resources and fisheries research, but it also focuses on crops, livestock, and forestry research themes.

The Santiago-based University of Chile is the country's largest in terms of student numbers and scientific publications. Agricultural research is directed primarily toward the various areas that constitute the food chain, as well as natural resources and the environment. The faculty operates six regional experimental stations, located between Regions IV and X, focusing mostly on livestock, grapes, and postharvest research (University of Chile 2008).

Research also constitutes one of the fundamental pillars of Concepción University (Region VIII) and it takes place within eight so-called research groups. Agricultural research within the Agro-Forestry Research Group takes a prominent position. The university is particularly well known for its research activities in the fields of precision agriculture, forestry biotechnology, the environment, and water.

National and International Linkages and Cooperation

Chile's agricultural R&D agencies participate in a significant amount of collaborative research nationally, regionally, and on an international basis. At the national level, government agencies, higher-education agencies, and the private sector are collaborating on an important body of work. The existence of a large number of competitive funds for agricultural R&D has forced Chilean agricultural R&D agencies to submit joint proposals for research projects and to carry out R&D activities together. INIA has established scientific and technological cooperation agreements with more than 45 international research institutions and organizations located in 25 countries. In addition, INIA researchers keep close professional contact with scientists and technicians at universities, research centers, and private businesses in many countries in Latin America, as well as Asia, Europe, and the United States. In South America, the institute participates in cooperative programs with research institutes in member countries of the Cooperative Program for the Agro-alimentary and Agro-industrial Technological Development of the Southern Cone (PROCISUR), coordinated by the Inter-American Institute for Cooperation on Agriculture (IICA). Countries that are members of PROCISUR include Argentina, Bolivia, Brazil, Chile, Paraguay, and Uruguay. Cooperation in this regard involves areas such as natural resources, genetic resources, biotechnology, and postharvest research activities. INIA has also provided technical assistance to government institutions in Afghanistan, Colombia, Haiti, Iran, and Nicaragua, by devising programs and executing agricultural sector projects. In addition, INIA maintains close ties with a number of centers under the Consultative Group on International Agricultural Research (CGIAR), including the International Maize and Wheat Improvement Center (CIMMYT) and the International Potato Center (CIP) (INIA 2008).

INFOR works closely with a large number of Chilean

universities and with Royal Dutch Shell on a project on genetically modified eucalyptus trees. It is also an active member in the International Union of Forest Research Organizations (IUFRO). Fundación Chile signed an agreement with the U.S.-based Biotechnology Center of Excellence Corporation (BCEC) and the Northern Regions Center (NRC) of Hokkaido, Japan, to promote joint research activities in agriculture, aquaculture, forestry, and food processing. Universidad de Chile has official cooperation agreements with a large number of institutes in Latin America, Europe, Japan, and South Korea. Similar cooperation agreements exist between other Chilean universities and foreign bodies.

HUMAN AND FINANCIAL RESOURCES IN PUBLIC AGRICULTURAL R&D

Overall Trends

The total number of public full-time agricultural researchers in Chile rose steadily at an average rate of 2.4 percent per year from 398 in 1981 to 690 in 2006 (Figure 1a). Growth was fairly consistent throughout this period, but slightly stronger during the 1980s, when research staff totals at INIA and the other government agencies rose rapidly. The relative share of government agencies other than INIA has risen gradually, at the expense of INIA and the higher-education agencies. Of note was the establishment of the two nonprofit agencies throughout this period, which by 2006 employed 22 full-time researchers, or 4 percent of Chile's total agricultural research work force.

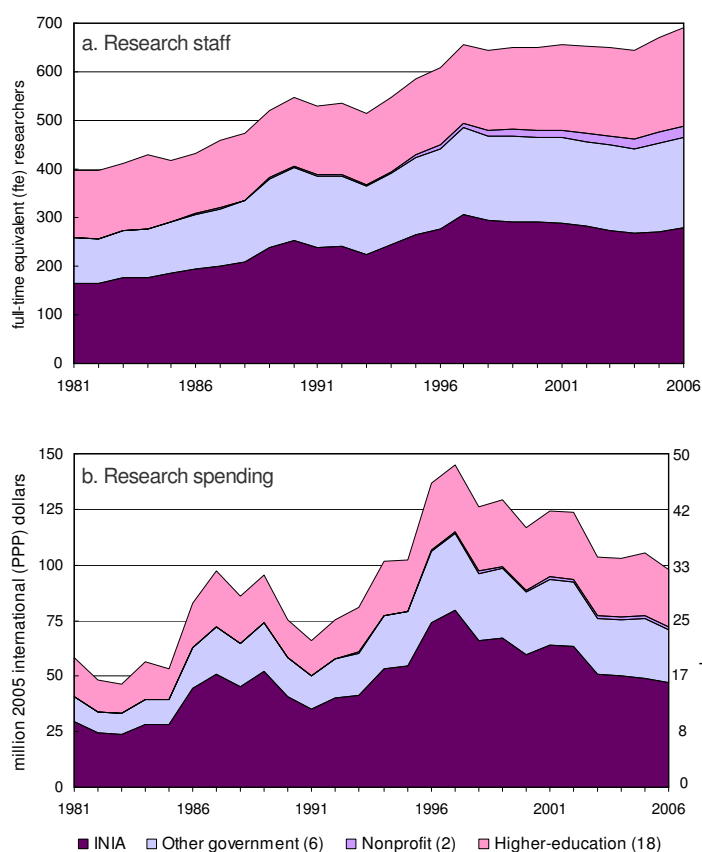
Total research staff at INIA grew steadily from 166 to 305 full-time equivalents during 1981–97, after which it declined, reaching 279 in 2006. In the 1990s, INIA attracted significant sums of external funding, which allowed the institute to hire scientists, mostly in emerging areas (such as biotechnology, precision agriculture, and molecular pathology). A mandatory retirement scheme for employees of 65 and older has caused researcher totals to decline somewhat in more recent years. Despite the fall in researcher totals in recent years, INIA is widely regarded as adequately staffed and in a position to satisfactorily serve Chile's agricultural R&D needs. The fact that the institute lost so many long-term staff due to the retirement law has also opened new opportunities for the institute, as most of the recently hired researchers are highly qualified young scientists with advanced skills in areas in which INIA had not been very active until now.

The total number of research staff at the other government agencies combined doubled from 92 to 187 full-time equivalents during 1981–2006. This increase was mainly due to a sharp rise in research capacity at INFOR, IFOP, and Fundación Chile. Chile's higher education sector also experienced a steady increase in its full-time research staff numbers. In 1981, the sector employed 140 full-time equivalents, compared with 202 in 2006. The Catholic University of Temuco and the University of Concepción, in particular, were largely responsible for this growth.

On average, total agricultural research spending in Chile nearly doubled at an average annual growth rate of 3.4 percent annually from \$58 million in 1981 to \$98 million in 2006 (in 2005 constant prices) (Figure 1b). Growth, however, did not occur equally over time and between agency categories. Spending rose during the second half of the 1980s due to a large project financed by the Inter-American Development Bank

(IDB) in support of INIA. The completion of this project led to a temporary decline in Chile's total agricultural R&D expenditures in the early 1990s. However, a second IDB agricultural-sector loan, which had a large component to upgrade INIA's physical infrastructure, combined with an increase in the allocation of public funds and internally generated resources at INIA, caused total Chilean agricultural R&D spending to rise dramatically from 1991 to 1997. The simultaneous completion of both this IDB-financed project and a large-scale national fertilization and prairie improvement project funded by the national government led to a severe decline in the country's total agricultural research investments in 1999. In 2000, INIA launched various cost-cutting measures and some unproductive personnel were laid off as part of this policy. These measures have led to a significant reduction in the institute's expenditures and have increased operational efficiency. During 1997–2006, total Chilean agricultural research spending contracted by 3.7 percent per year, on average.

Figure 1—Composition of public agricultural research staff and spending, 1981–2006



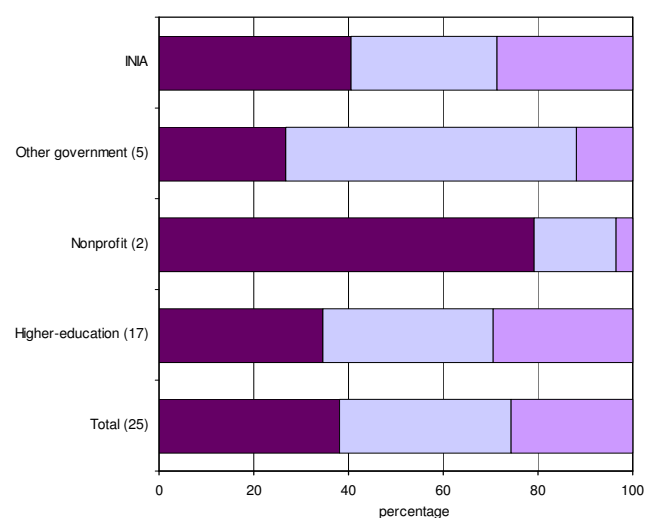
Sources: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08), Castelo Magalhães et al. (2002), and a number of agency websites.

Notes: See Table 1. Figures in parentheses indicate the number of agencies in each category. Staff and expenditure data for the other government agencies were unavailable for some years. Data for the missing years have either been interpolated or extrapolated based on data for INIA.

Human Resources

In 2006, more than 60 percent of the 581 fte researchers in our 25-agency sample were trained to the postgraduate level, and 26 percent held PhD degrees (Figure 2). These averages mask large variations between the different institutional categories. With nearly four-fifths holding BSc degrees, agricultural research staff in the nonprofit agencies was the least qualified. Close to 30 percent of the scientists at INIA and the higher education agencies were trained to the PhD level. This share was much lower for the other government agencies category (12 percent). However, more than 60 percent of researchers in this category held MSc degrees in 2006.

Figure 2—Educational attainment of researchers by institutional category, 2006

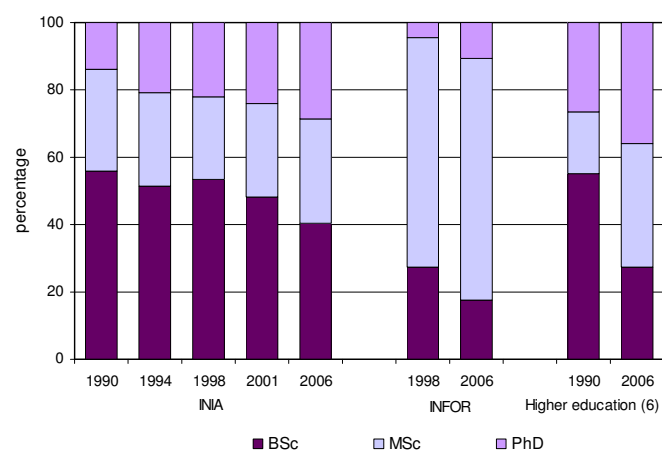


Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08). Notes: Figures in parentheses indicate the number of agencies in each category. Other government (5) excludes IFOP. Higher education (17) excludes the Faculty of Agricultural and Forestry Sciences of the Catholic University of Maule.

The increased role of competitive funds in financing agricultural R&D in Chile has created a very competitive environment in which agricultural research agencies invest heavily in the training of their research staff, in order to be in a better position to secure funding for their own research. Average qualification levels of Chilean agricultural R&D staff have improved considerably during 1990–2006 (Figure 3). In 1990, 44 percent of researchers at INIA were trained to the postgraduate (PhD or MSc) level, compared to 60 percent in 2006. The share of PhD holders at INIA doubled during this period, from 14 percent to 29 percent. INIA actively encourages its scientists to pursue postgraduate training, in addition to supporting various short training courses abroad and exchanges with international research centers and universities. For many years, INIA has financed MSc and PhD training for its scientists through its own resources. However, due to the recent cost-cutting measures mentioned above, the number of INIA scientists sent for training each year has declined. In 1997, 43 researchers received formal postgraduate training; by 2000, this total had dropped to 38, while in 2006, there were just 11. Each professional that receives postgraduate training must commit to remaining with INIA for at least twice the duration of the

training. Traditionally, most researchers were sent to universities in the United States. However, with a rise in multiple agreements between INIA (and the Chilean government more generally) and foreign universities, an increased number of INIA scientists have received postgraduate training in Australia, France, Japan, New Zealand, Spain, and the United Kingdom. The high costs that INIA incurred in the past to train its researchers are now paying off. Chile currently possesses one of Latin America's most highly qualified agricultural research forces. In Argentina and Colombia, for instance, the 2006 shares of research staff with postgraduate training totaled 41 and 42 percent, respectively (Stads and Beintema 2009).

Figure 3—Educational attainment of researchers by institutional category, 1990-2006



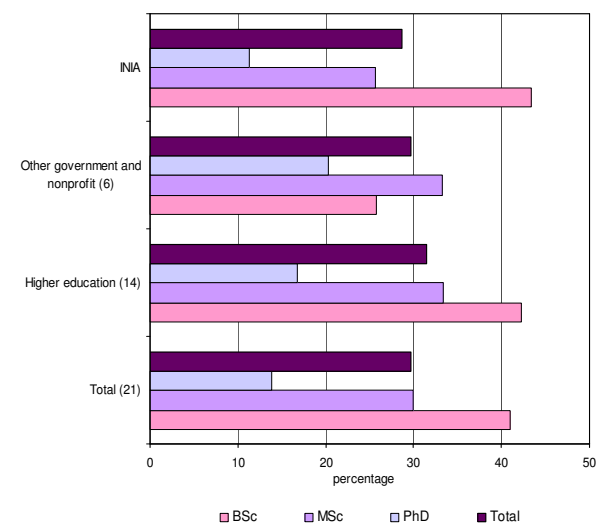
Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08) and Castelo Magalhães et al. (2002).

Notes: Figures in parentheses indicate the number of agencies in each category. The six higher education agencies accounted for a combined share of 46 percent of total agricultural research staff in the higher education sector in 2006.

Similarly, the average share of agricultural scientists holding postgraduate degrees in a sample of six Chilean universities rose dramatically from 45 percent in 1991 to 73 percent in 2006. The number of MSc-qualified researchers rose particularly fast during this period, especially at the University of Chile. Like INIA, many universities send their researchers for postgraduate training, either within Chile or abroad. INFOR also reported an improvement of average qualifications of its research staff over the 1998-2006 period.

Despite a rise in the number of women pursuing scientific careers worldwide, females still tend to be underrepresented in senior scientific and leadership positions (IAC 2006). Chile is no exception in this regard. In 2006, 30 percent of Chile's total fte researchers in a 21-agency sample were female, ranging from 14 percent of those holding doctorate degrees to 30 and 41 percent of all researchers trained to the MSc and BSc level, respectively (Figure 4). Only minor differences were observed between the various agency categories, with the overall share of female researchers being the highest at the higher-education agencies (31 percent). The share of PhD-qualified women was highest at the "other government agencies" category (20 percent). The gender gap in PhD qualifications is most pronounced at INIA and within the higher age brackets.

Figure 4—Share of female researchers, 2006

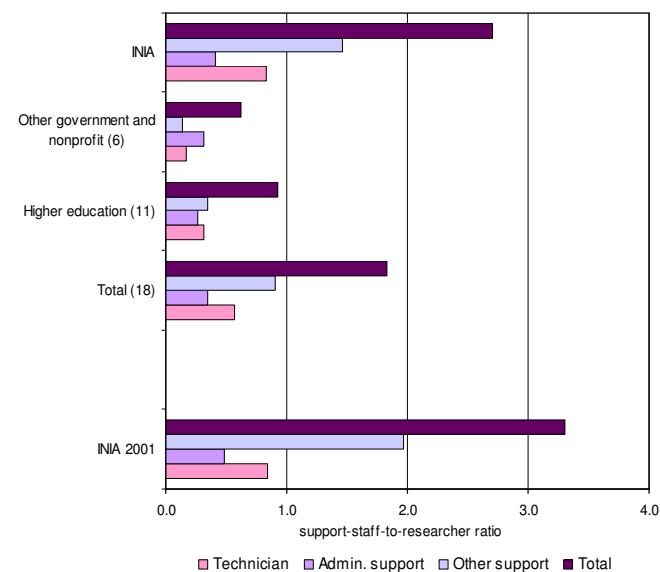


Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08).

Notes: Figures in parentheses indicate the number of agencies in each category. The sample excludes FDF, the Catholic University of Maule, and three agencies under the University of Concepción.

In 2006, the average number of support-staff-per-scientist in an 18-agency sample for which data were available was 1.8, comprised of 0.6 technicians, 0.4 administrative personnel, and 0.9 other support staff such as laborers, guards, drivers and so on (Figure 5). Consistent with findings in most developing countries around the world, Chile's 2006 support-staff-per-researcher ratio for the 11 higher-education agencies included in our sample (0.9) was much lower than the corresponding ratio for the principal government agency—INIA (2.7). In 2001, INIA's support-staff-per-scientist ratio was at 3.3. The decline was mainly the result of a sharp fall in staff in the "other support staff" category.

Figure 5—Support-staff-to-researcher ratios, 2006



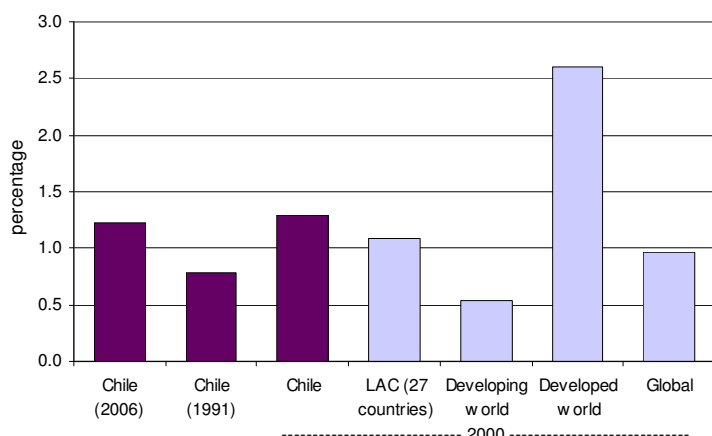
Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08).

Notes: Figures in parentheses indicate the number of agencies in each category. The sample excludes FDF, three agencies under the University of Concepción, the University of Maule, the University of Los Lagos, the University of Talca, and the University of La Serena.

Spending

Total public spending as a percent of agricultural output (AgGDP) is a common research investment indicator that helps place a country's agricultural R&D spending in an internationally comparable context. In 2006, Chile invested \$1.22 on agricultural research for every \$100 of agricultural output, which was well above the corresponding ratio in 1991 (0.79), but lower than the level recorded in 2000 (1.30) (Figure 6). The 2000–06 drop in Chile's agricultural research intensity ratio is the result of the aforementioned fall of public agricultural R&D expenditures, in combination with a steady increase in the country's AgGDP (in 2005 constant prices). The 2006 ratio for Chile was higher than the reported 2006 average for Latin America and the Caribbean (1.14) and the 2000 ratio for the developing world (0.55), but lower than the 2000 ratio for the developed world (2.35) (Stads and Beintema 2009; Beintema and Stads 2008). Chile's agricultural research intensity ratio is also much higher than the country's overall (agricultural and nonagricultural) S&T intensity ratio (0.68) (RICYT 2008).

Figure 6—Chile's agricultural research intensity compared regionally and globally

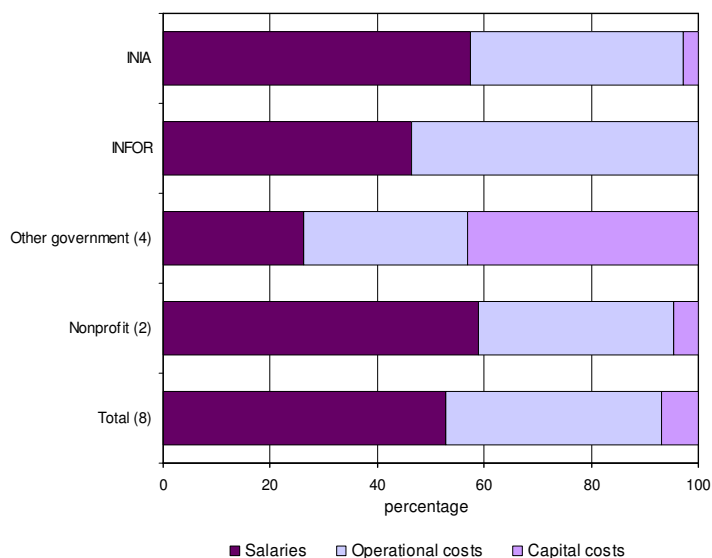


Sources: Chile data are compiled from Figure 2; AgGDP data are from World Bank (2008); all other intensity ratios are from Beintema and Stads (2008). LAC stands for Latin America and Caribbean.

In 2006, salaries accounted for 53 percent of total expenditures for a sample consisting of eight Chilean government and nonprofit agencies, operating costs for 40 percent, and capital costs for 7 percent (Figure 7). These overall averages mask some important variations between the agency categories. Capital spending shares showed similar variation. In 2006, INIA, INFOR, and the nonprofit agencies, for example, spent 4 percent or less on capital, compared with the agencies in the other government category (43 percent). The latter share was so high because of consistently high capital expenditures at Fundación Chile. As previously mentioned, this foundation launches demonstration companies as a means of commercializing new technologies, then sells those enterprises once they have become viable. Capital spending is high as a result.

As previously mentioned, INIA's budget has steadily declined since 1997. Despite a drop in the total number of research and support staff, the relative share of salary costs in INIA gradually increased from 44 percent in 1997 to 57 percent

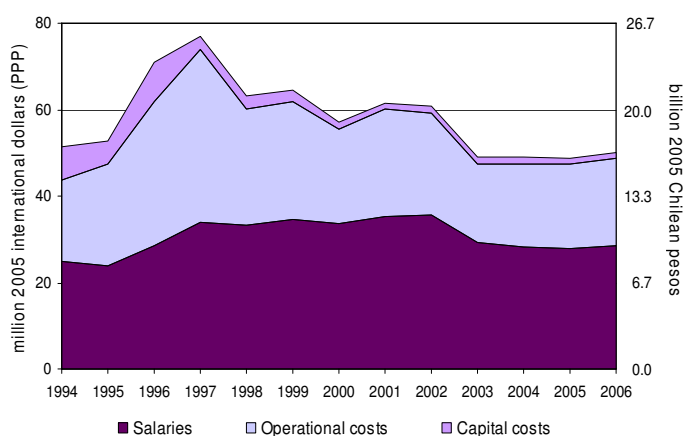
Figure 7—Cost category shares in government and nonprofit agencies' expenditures, 2006



Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08)

in 2006 (Figure 8). Capital expenditures were relatively high at INIA during 1994–96 due to an influx of IDB funding, but have not exceeded 5 percent of total expenditures since.

Figure 8—Cost category shares in INIA's expenditures, 1994-2006



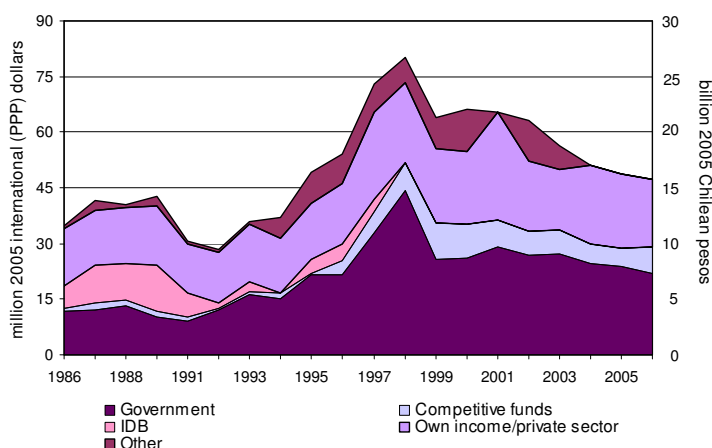
Sources: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08) and Castelo Magalhães et al. (2002).

The budgets of virtually all of Chile's public agricultural R&D agencies are annually determined and approved by the national parliament, as part of the so-called Budget Law of the Nation. The agencies then receive these funds from the respective ministries under which they fall. Being a (semi-) private organization, INIA can establish its own salary scales. The other government and higher education agencies, on the other hand, offer salary scales that are fixed by law. Overall, salaries paid to INIA staff are similar or slightly higher than those paid in other government agencies. However, salaries for agricultural researchers in the private sector are reportedly 25 to 30 percent higher, which at times leads to the departure of public-sector research staff (higher education agencies in particular) to the private sector.

FINANCING PUBLIC AGRICULTURAL R&D

Over the past decade, funding for agricultural research in Chile has come from a number of sources, principally the national government, internally generated resources, competitive funds, contract research for public/private enterprises, and loans from development banks. The composition of INIA's funding sources developed erratically during 1986–2006 (Figure 9). Total government support to the institute rose steadily in the 1990s, peaking at \$44 million in 1998 and contracting significantly after that. During 2004–06, less than half of INIA's total funding was provided by the Chilean government. In fact, total direct government appropriations do not cover INIA's salary expenditures. The institute therefore has to look for additional funding sources elsewhere to make ends meet. Researchers at INIA have to secure funding for operational expenditures through a variety of other sources, including competitive grant schemes. If they fail to do so, they will have no funds to carry out their research. This has created a highly competitive environment in which research organizations such as INIA and the universities directly compete for funding.

Figure 9—Funding sources of INIA, 1986–2006



Sources: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08) and Castelo Magalhães et al. (2002)

The share of internally generated resources in INIA's total funding has been consistently high during 1981–2006. During 2004–06, roughly one-third of the institute's funding was derived through the sale of products (mainly seeds), technologies, and contract research for the private sector. During 1986–91, direct government funding accounted for just 30 percent of INIA's total funding. This can be largely explained by the large influx of funding from IDB. In 1987, INIA obtained an IDB loan in the amount of US\$32.5 million to purchase equipment, build research infrastructure, and finance a program of advanced training for INIA scientists. During 1992–97, INIA obtained an additional US\$9.4 million agricultural sector loan from IDB to be used primarily to support research that benefited small farmers. INIA has not received any direct IDB funding since 1997. However, IDB plays an important role in (financially) supporting competitive funds, including the recently established INNOVA CHILE.

IFOP receives the lion's share of its funds through direct allocations from the Chilean government or through competitive

funding schemes. INFOR's research is largely financed by the Chilean government; the private sector (either through direct allocations or through competitive funds); and a number of donors, including the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Program (UNDP), IDB, the World Bank, and the Japanese International Cooperation Agency (JICA). Fundación Chile is largely financed by competitive funds and by the private sector businesses it establishes and maintains.

Agricultural research in Chile's higher education sector is financed through a variety of sources. The Chilean government provides grants to universities, including research funds to contract staff. In addition, universities also carry out contract research for the national government, mostly for applied and adaptive research projects. Besides, competitive funds play an important role in allocating funding to university-led agricultural R&D. Contract research for domestic and foreign private-sector companies, as well as the sale of research goods and services, plays a significant role in financing R&D in certain universities as well. In 1987, the Chilean government introduced a 50 percent tax deduction for donations from the private sector to universities and many universities now carry out privately financed research. Research efforts at the Catholic University of Temuco are largely financed through regional and national competitive funds, government agencies like INFOR, and limited funds from foreign donors including Spain, the World Bank, and Sweden's International Foundation for Science (IFS) (Catholic University of Temuco 2008). Concepción University and the University of Chile also reported funding from a large number of government sources and regional and national competitive funds, as well as from the British Council, Comisión Fulbright, and Fundación Andes (UdeC 2008; University of Chile 2008).

Competitive Funds

Starting in the 1980s, Chile was one of the first countries in Latin America to introduce competitive funding mechanisms for agricultural R&D. Several funds are currently in operation with substantial public financial support. These funds seek to increase the accountability of researchers, to improve research resource allocation and technology transfer by promoting more effective linkages between research institutes and agricultural producers, and to lower costs by supporting demand-driven research. They have helped to significantly increase the volume and quality of Chilean (agricultural and nonagricultural) research, as well as to introduce better-defined research agendas for both private and public research agencies. Competitive funds are generally available to government agencies, higher education agencies, nonprofit institutions, the private sector, and individuals on a nationwide basis. The most important competitive funds in operation in the agricultural field in Chile are the National Fund for Science and Technology Development (FONDECYT), the Fund for the Promotion of Scientific and Technological Development (FONDEF), INNOVA CHILE, the Agricultural Innovation Fund (FIA), and the Fund for Fisheries Research (FIP). The Innovation Fund for Competitiveness (FIC) is also important, but at a broader (nonagricultural) level. Each of these funds focuses on different themes or areas of (agricultural) S&T and they all require private-sector involvement through counterpart funding or collaborative research in order to ensure that the research will be used on an

industrial basis. Private-sector companies can finance part of the project directly or allow researchers to use company infrastructure, raw materials, or workforce. Companies must sign a contract detailing their commitment as a condition for applying to the fund. CORFO promotes extensively the results of the projects it finances through FDI, FONDEF, and FONTEC to companies through trade shows and public expositions. The objective is to stimulate the private sector to actively co-finance R&D projects and to invite them to use these funds to find solutions to their own R&D needs. In addition, research proposals by universities or research institutes must show that the result of their projects will have an effective industrial use and result in gains of productivity, creation of new jobs, or an increase in exports.

FONDECYT

FONDECYT is the largest competitive fund in Chile. Founded under the umbrella of the National Commission of Scientific and Technological Research (CONICYT) in 1982, the fund's principal objective is financing scientific and technological research projects of a high level of excellence in all areas of knowledge, irrespective of the field or of the institution involved. Unlike most other competitive funds, FONDECYT does not finance a particular theme or area of research; instead the criterion for funding a certain project is based solely on the quality of the proposal. The areas supported are mathematics, physics, chemistry, biology, earth sciences, astronomy, engineering, medicine, agronomy, and social sciences. Agricultural projects accounted for less than 5 percent of supported projects during 1982–2007. In 2007, more than 90 percent of FONDECYT's funds totaling 27 billion current Chilean pesos were disbursed to the higher education sector, particularly large universities like the University of Chile and the Pontificia Catholic University of Chile. Government agencies were the recipients of just 1 percent of FONDECYT funding during the same year, down from 3 percent in 1990 (FONDECYT 2008).

FONDEF

Administered by CONICYT, FONDEF was founded in 1991 with an aim to strengthen Chile's R&D capacity, to increase the quantity and quality of S&T, to expand the supply of services related to S&T, and to transfer S&T knowledge effectively to productive sectors. All the projects selected by FONDEF should have an R&D component, a high socioeconomic impact, be co-financed with private sector companies or other counterparts, and oriented toward the creation of relevant technological businesses. Private and other enterprises are eligible for funding, as long as there is a technology transfer component embedded in the project. Besides agriculture, forestry, and fisheries, FONDEF also funds projects related to mining, health, education, infrastructure, and information and communication technologies. During 1991–2006, FONDEF has awarded 139 million current Chilean pesos to 614 R&D projects. More than half of these funds were allocated to agricultural projects (15 percent to crop and livestock projects, 10 percent to forestry projects, and 29 percent to fisheries projects). As is the case with FONDECYT funding, universities (especially the University of Concepción and University of Chile) received the lion's share of FONDEF funding. During 1996–2004, INIA

received just 3 percent of total FONDEF resources. Today, 30 percent of the projects financed have international participation (FONDEF 2008).

INNOVA CHILE

INNOVA CHILE was established in 2005 through a merger of the National Fund for Technological and Productive Development (FONTEC, founded in 1995) and the Development and Innovation Fund (FDI, founded in 1991), and it was also assigned additional responsibilities. Its mission is to help raise the competitiveness of the Chilean economy, through the promotion and facilitation of business-led innovation, a stimulation of entrepreneurial development, as well as through strengthening the national innovation system. In 2008, INNOVA CHILE's total budget was US\$48 million (US\$200 million if private-sector contributions are included). The exact share of the agricultural research project financed by INNOVA CHILE is difficult to determine. However, many fruit growers, fish farms, and biotech and seed companies have received support from the fund, as have public-sector agencies like INIA and INFOR.

FIA

FIA was established in 1981 by MINAGRI as an autonomous institution charged with the promotion of research in Chile's agricultural sector. It is the country's only fund that is fully dedicated to the agricultural sector. The fund finances R&D of innovative initiatives and stresses the importance of internationalization of Chilean research. It also aims to improve exchanges between agricultural researchers, farmers, and agricultural companies. FIA provides partial financing to several agents involved in innovation, production or research with commercial goals in areas like agriculture, livestock, agroforestry, and fresh-water fisheries. The fund finances only 70 percent of the project and requires a 30 percent counterpart funding share from the recipient(s). During 1996–2006, FIA disbursed 21 billion current Chilean pesos to 313 different projects. 55 percent of these projects were related to crop research and 27 percent to livestock research. More than one-third of total funding was disbursed to universities, 19 percent to government agencies, 11 percent to the private sector, and the remainder to producer associations, individual producers, or others (Galaz 2007).

FIP

FIP was established in 1991 as a sector-specific government fund for research aimed at applications in the fishing and aquaculture industries. It plays a complementary role to FIA in terms of emphasis, with all funds going into fishery and aquaculture research, research into resource management, conservation, or relevant environmental issues. Universities, government institutes, as well as the private sector are eligible for FIP funding. The size of FIP has increased rapidly in recent years. In 2003, the fund disbursed 2 billion current Chilean pesos, compared to 4 billion in 2007. IFOP, Concepción University, and the Southern University were the principal recipients of FIP funding (FIP 2008).

FIC

FIC, administered by CNIC, is charged with proposing programs and actions that strengthen Chile's innovative capacities in the regions, while at the same time ensuring national coherence in the field of innovation. The fund was established in 2006 and finances R&D, technology transfer, and human resource training projects. All funds are channeled through CORFO and CONICYT, which by law, are required to devote a share of their funds to regional programs. In 2006, FIC disbursed 43 million current Chilean pesos, 60 percent of which went to the mining sector, and the remainder to a variety of other sectors, although these shares varied from one region to the next. During the first year of a project, no counterpart funding from the regional government is required. After one year, the regional government funds 20 percent of the project costs, and in the third year, it funds at least one-third.

Overall, competitive funds have clearly improved the efficiency of the Chilean national innovation system and its responsiveness to S&T needs. Not only have these funds enhanced collaboration between the country's R&D agencies, they have also raised the return of public investments in agricultural R&D and have caused a tremendous change for the better in research institutions and individual researchers in the way they manage their research projects and handle problems, goals, methods, and costs. The strict requirements of project proposals have led to a streamlining of administrative procedures of many R&D agencies, of their day-to-day operations, and to an introduction of new R&D themes (which are more likely to attract funding). The funds themselves are also continuously evolving in order to better serve the country's S&T needs.

However, although the majority of the funds function very well individually, there is some degree of overlap and duplication among them. This sometimes causes rivalry between the various funds. Moreover, Byerlee and Echeverría (2002) argue that there is a risk that reliance on short-term competitive funding could lead to opportunistic research programs, initiated in response to the availability of funding sources, that may not represent the highest priorities for the country or for farmers and in any event may not add up to a coherent portfolio of projects. The establishment of a single body that oversees the various competitive funds could solve some of these problems. Some also call for the introduction of more sector-specific competitive funds, because the specificities of certain sectors are too complex to be solved by so-called "horizontal" funds. In addition, an increased commitment from the private sector is needed to ensure the relevance of funding proposals, as well as the use of the research outcomes generated by competitively funded projects. Private-sector contributions to Chile's competitively funded projects currently do not exceed 15 percent, but it is believed that with time, the private sector will see the benefits of contributing to these funds and step up its investments in R&D.

PRIVATE AGRICULTURAL R&D

Private-sector involvement in Chilean agricultural R&D has increased with the creation of competitive funds, which require private-sector involvement. Many private investors have grouped themselves into consortia in which they identify

common research needs and develop clear long-term (typically five-year) research agendas. These consortia require financial inputs from each member. The remainder is paid by counterpart funding from the public sector. The resulting research outputs and prototypes are owned by the participating companies and can be used later for commercial purposes. INIA is a partner of some of these consortia, including the ones for dairy, potatoes, fruits, and sheep.

Only a few private-sector companies carry out their own agricultural R&D. Semillas Baer, a cereals company in the South of Chile, is involved in seed research (mainly wheat). Other companies only sporadically conduct research, taking advantage of some government incentives, but in most cases they prefer to contract their research out to INIA or the university sector, as is the case with many agro-food companies (potatoes, wheat, fruits, vegetables, salmon, pesticides, and fertilizers, among others).

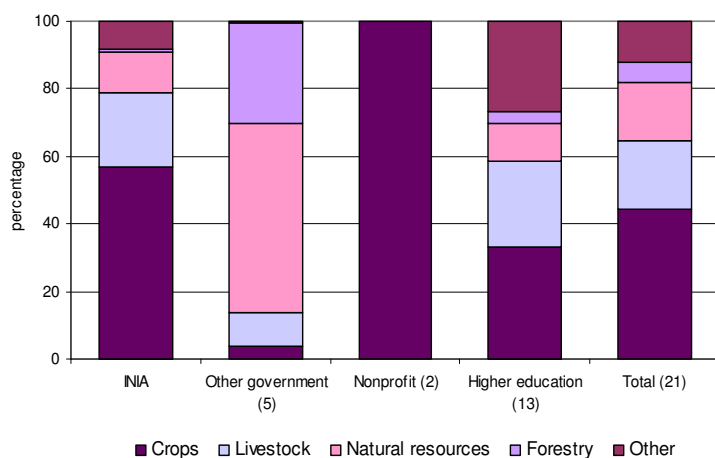
In January 2008, the Chilean government launched a series of tax incentives for private companies in Chile who hire universities or research centers to conduct R&D on their behalf. With these incentives, companies will be able to use 35 percent of the money they normally pay in taxes to invest in R&D. This is equivalent to receiving a state contribution of US\$46 for every US\$100 invested in R&D, according to the government. This law is an opportunity for companies who want to innovate under their own terms, without applying for grants or project competitions (Leighton 2008).

RESEARCH ORIENTATION

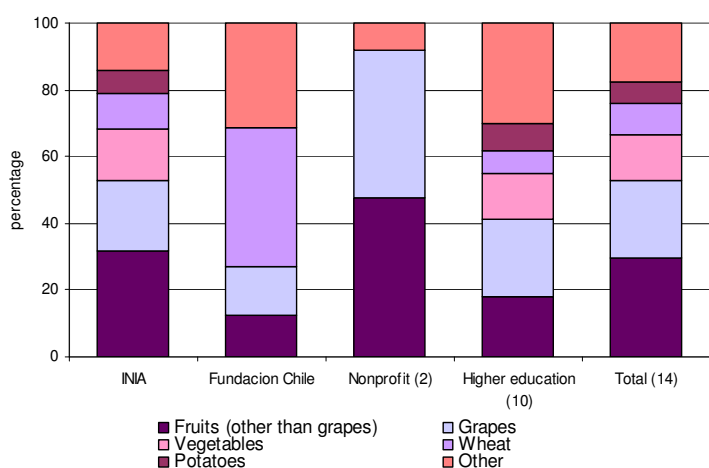
Because the allocation of resources among various lines of research is a significant policy decision, detailed information was collected on the number of fte researchers working in specific commodity and thematic areas. In 2006, 44 percent of the 536 fte researchers of a 21-agency sample conducted crop research. Livestock research accounted for 20 percent of the total, natural resource research for 18 percent, and forestry research for 6 percent each (Figure 10a). Research staff at INIA spent relatively more time on crop research than their counterparts at the higher education agencies. The category "other" was particularly high at the higher education agencies, which can largely be explained by the fact that basic sciences are included in this category. Of note is the strong focus on natural resources by researchers in the "other government agencies" category (56 percent), largely due to CIMM, CENMA, CIREN, and INFOR, which focus on a variety of environmental research themes. Fruits (other than grapes) accounted for 30 percent of the research conducted on crops, grapes for 23 percent, vegetables for 14 percent, wheat for 10 percent, and potatoes for 7 percent (Figure 10b). The importance of fruit and wine exports to the Chilean economy are clearly reflected in these figures. Most livestock researchers focused their research efforts on beef (31 percent) or dairy (24 percent). Other livestock themes included sheep and goats (15 percent), pastures and forages (14 percent), and poultry (2 percent) (Figure 10c). INIA research staff carries out 56 percent of Chile's livestock research.

Figure 10—Commodity focus

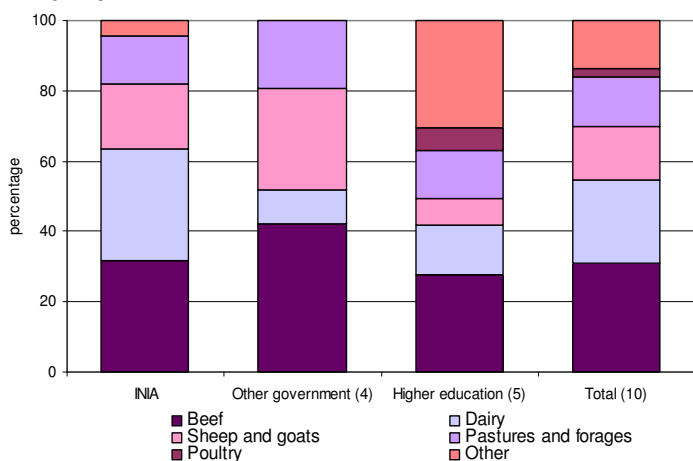
a. by major item, 2006



b. by major crop item, 2006



c. by major livestock item, 2006



Source: Compiled by authors from ASTI survey data (IFPRI-INIA 2007-08).
 Notes: Figures in parentheses indicate the number of agencies in each category.
 Figure 10b only includes agencies involved in crop research; Figure 10c only includes agencies involved in livestock research.

CONCLUSION

Despite a decrease in the total number of researchers at INIA in recent years, overall agricultural research capacity in Chile rose gradually during 1981–2006. In 2006, the country as a whole employed close to 700 fte scientists involved in agricultural R&D. The country's agricultural R&D spending, however, developed more erratically. The completion of a large IDB-financed project, in addition to cost-cutting measures introduced by INIA, have led to a gradual fall in the country's expenditures since the late 1990s. In 2006, Chile invested just under \$100 million (in 2005 constant prices) on agricultural R&D, or 1.22 percent of its AgGDP. Despite the fall in total agricultural R&D spending in recent years, Chile compares favorably to many of its Latin American counterparts, in terms of public-sector intensity of investment in agricultural R&D.

Although internally generated resources play a very important role in financing Chilean agricultural R&D, the lion's share of the country's R&D investments are financed by the national government, either through general appropriations or through a number of competitive funds, which typically require counterpart funding from the private/productive sector. A large number of competitive funds in support of agricultural R&D exist side by side, on occasion with overlapping or duplicating focus, sometimes leading to research programs that add up to an incoherent project portfolio or programs that do not always serve the priorities of the country as a whole. Nonetheless, these competitive funds have enhanced cooperation among R&D agencies, as well as between agencies and the private sector, and are said to have made the day-to-day operation of many R&D agencies much more efficient.

Overall, Chile's agricultural R&D system is adequately staffed and funded and has played a critical role in the emergence of the country's fruit, wine, and salmon industries in recent decades. However, the complex institutional structure of the various competitive funds and agencies involved in S&T policy formulation sometimes leads to confusing procedures and an unnecessary (and costly) overlap and duplication of activities. The establishment of an effective single national institute responsible for S&T policy could solve many of these problems. In addition, the country needs a clear long-term strategy that involves both the public and the private sector if it is to maintain and enhance its competitive position in a global market.

NOTES

1. The authors are grateful to numerous colleagues in Chile for their time and assistance with the data collection, and thank Nienke Beintema, Alicia Bruna, Ayleen González, and Leopoldo Sánchez for their useful comments on drafts of this brief.
2. The 27-agency sample consisted of
 - 7 government agencies/units: the *Instituto de Investigaciones Agropecuarias* (INIA), the *Instituto de Fomento Pesquero* (IFOP), the *Instituto Forestal* (INFOR), the *Centro de Investigación Minera Metalúrgica* (CIMM), the *Centro Nacional del Medio Ambiente* (CENMA), the *Centro de Información de Recursos Naturales* (CIREN), and the *Fundación Chile*;
 - 2 nonprofit agencies: the *Fundación para el Desarrollo Frutícola* (FDF), and the *Corporación Agraria para el Desarrollo* (CAD);
 - 18 higher education agencies: the *Facultad de Ciencias Agronómicas* and the *Facultad de Ciencias* of the *Universidad de Chile*, the *Facultad de Ingeniería, Ciencias y Administración* of the *Universidad de la Frontera*, the *Dirección de Investigación* of the *Universidad de Los Lagos*, the *Facultad de Ciencias Agronómicas* of the *Universidad de Tarapaca*, the *Dirección General de Investigación* of the *Universidad Católica de Temuco*, the *Facultad de Agronomía* of the *Pontificia Universidad Católica de Valparaíso*, the *Facultad de Agronomía e Ingeniería Forestal* and the *Facultad de Ingeniería Química y Bioprocesos* of the *Pontificia Universidad Católica de Chile*, the *Facultad de Ciencias Agrarias* of the *Universidad de Talca*, the *Departamento de Industrias* of the *Universidad Técnica Federico Santa María*, the *Facultad de Ciencias Agrarias* of the *Universidad Austral de Chile*, the *Facultad de Ciencias Agrarias y Forestales* of the *Facultad Católica de Maule*, the *Facultad de Agronomía*, the *Facultad de Ciencias Veterinarias*, and the *Facultad de Ingeniería Agrícola* of the *Universidad de Concepción*, the *Facultad de Ciencias Silvoagropecuarias* of the *Universidad Mayor*, and the *Departamento de Agronomía* of the *Universidad de La Serena*.
3. Unless otherwise stated, all data on research expenditures are reported in 2005 international (PPP) dollars or in 2005 Chilean pesos.
4. English translations of agency names have been used throughout the brief except in note 2, where the original Spanish is provided.
5. However, following the institutional classification in the Frascati Manual (see OECD 2002) a research agency that is not administered by but receives more than half of its annual funds from the government—like INIA, IFOP, and INFOR—is still classified as a government agency.
6. Chile is divided into 15 regions. The regions have formally both a name and a Roman numeral (for example, VI, sixth), with the numbers originally assigned in sequence from north to south (the 2006 inclusion of three new regions—Región de Los Ríos (Region XIV), Región de Arica y Parinacota (Region XV), and Región Metropolitana de Santiago (RM)—has changed this
7. Fundación Chile is a technology center that improves the technical performance of economically important sectors by creating new companies, rather than by attempting to upgrade the technological performance of existing firms. It launches demonstration companies as a means of commercializing new technology and sells those enterprises once they have become viable.

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METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI-INIA 2007-08) and Castelo Magalhães, Beintema, and Martinez (2002).
- The data were compiled using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 2002; UNESCO 1984). The authors grouped estimates using three major institutional categories—government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and nonprofit institutions. The researchers defined public agricultural research to include government agencies, higher-education agencies, and nonprofit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre, on, and postfarm technologies related to agriculture.
- Agricultural research includes crops, livestock, forestry, and fisheries research plus agriculturally related natural resources research, all measured on a performer basis.
- Financial data were converted to 2005 international dollars by deflating current local currency units with a Chilean GDP deflator of base year 2005 and then converting to U.S. dollars with a 2005 purchasing power parity (PPP) index, taken from World Bank (2008). PPP's are synthetic exchange rates used to reflect the purchasing power of currencies, typically comparing prices among a broader range of goods and services than conventional exchange rates.
- Annual growth rates were calculated using the least-squares regression method, which takes into account all observations in a period. This results in growth rates that reflect general trends that are not disproportionately influenced by exceptional values, especially at the end point of the period.

See the ASTI website (<http://www.ASTI.cgiar.org>) for more details on methodology.

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