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PUBLIC AGRICULTURAL R&D IN SOUTH ASIA:

Greater Government Commitment, Yet Underinvestment Persists

Gert-Jan Stads and Michael Rahija

ASTI Synthesis Report • September 2012

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International Food Policy Research Institute | Washington, DC
Agricultural Science and Technology Indicators | Rome, Italy

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ABOUT IFPRI

The International Food Policy Research Institute (IFPRI) seeks sustainable solutions for ending hunger and poverty. IFPRI is a member of the CGIAR Consortium. (www.ifpri.org and www.cgiar.org)

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) initiative compiles, analyzes, and publishes data on institutional developments, investments, and human resources in agricultural R&D in low- and middle-income countries. The ASTI initiative is managed by the International Food Policy Research Institute (IFPRI) and involves collaborative alliances with many national and regional R&D agencies, as well as international institutions. The initiative is widely recognized as the most authoritative source of information on the support for and structure of agricultural R&D worldwide. (www.asti.cgiar.org)

DOI: http://dx.doi.org/10.2499/9780896298002

ISBN number: 978-0-89629-800-2

Design: Joan Stephens | JKSDesign

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Acknowledgments

This report was developed with funding from the Bill & Melinda Gates Foundation and the Asian Development Bank. The authors thank their country collaborators and the more than 300 agricultural research agencies that participated in national survey rounds; without their commitment, this report would not have been possible. The authors also thank Nienke Beintema, Kathleen Flaherty, Suresh Pal, Mark Rosegrant, and Attaluri Srinivasacharyulu for their excellent help in reviewing and commenting on a draft version of this publication.

Acronyms

AgGDP	agricultural gross domestic product
ALP	Agricultural Linkages Program
APAARI	Asia Pacific Association of Agricultural Research Institutions
AREP	Agricultural Research and Extension Project
ASTI	Agricultural Science and Technology Indicators
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
CCRP	Competitive Contract Research Program
CGIAR	Consultative Group on International Agricultural Research
DFID	U.K. Department for International Development
FTE	full-time equivalent
ICAR	Indian Council for Agricultural Research
IFPRI	International Food Policy Research Institute
IPR	intellectual property rights
IRRI	International Rice Research Institute
NAIP	National Agricultural Innovation Programme
NARC	National Agricultural Research Center [Pakistan]
NARC	Nepal Agricultural Research Council [Nepal]
NARDF	National Agricultural Research Fund
NARP	National Agricultural Research Plan
NGOs	nongovernmental organizations
PARC	Pakistan Agricultural Research Council
PPP	purchasing power parity
R&D	research and development
SAARC	South Asian Association for Regional Collaboration
SAUs	State Agricultural Universities
SLCARP	Sri Lanka Council for Agricultural Research Policy
UGC	University Grants Commission

Overview

The Rationale for Monitoring the Allocation of Agricultural R&D Resources

South Asia has made remarkable progress toward economic growth and poverty reduction since the turn of the millennium; nevertheless, the subregion is still home to nearly half the world's poor and malnourished people. In 2008, 571 million South Asians lived on less than $1.25 per day, a global measure of extreme poverty. Poverty and malnutrition in the subregion are not only widespread, but also increasingly concentrated in lagging rural areas, where roughly three-quarters of South Asia's poor people reside. The vast majority of the rural poor depend on the production of rainfed crops, livestock, forestry, and informal (often migratory) employment for their livelihoods (World Bank 2008, 2012a).

To provide a pathway out of poverty for the subcontinent's rural poor and to tackle the widening rural–urban income gap, a revival of the agricultural sector is urgently needed. The World Bank predicts that the population of South Asia will reach 2.5 billion people by the year 2050, up from 1.6 billion today. In order to feed these 900 million extra people and to address other pressing challenges—including adaptation to climate change and rising and volatile food prices—it is crucial that agricultural productivity in the subregion is increased without delay.

A persuasive body of empirical evidence has demonstrated that agricultural research and development (R&D) has been a major contributor to agricultural innovation, productivity increases, and poverty reduction around the globe over the past five decades (World Bank 2007; IAASTD 2008). From the 1960s through the 1980s, the so-called Green Revolution allowed significant increases in agricultural production in South Asia through the implementation of research-based agricultural methods and new technologies. These had a tremendously positive impact on food security and rural incomes; more recently, however, the impact of the Green Revolution has begun to level off. Further, the challenges that South Asia's rural population face remain daunting. Land and water have become increasingly scarce in some parts of the subcontinent as these resources have been diverted to nonagricultural activities, while misguided government policies together with climate change and rising fuel prices have added to the woes (World Bank 2008). All over the subcontinent, the call for a reinvigoration of the agricultural sector has intensified in recent years. Effective and well-targeted agricultural R&D plays a key role in this regard.

Despite the well-documented evidence that the payoffs to agricultural research are considerable, many developing countries continue to underinvest in agricultural R&D. Given the substantial time lag between investing in research and reaping its rewards—which is typically decades, not just years—agricultural R&D requires a long-term commitment in terms of sufficient levels of sustained funding and well-staffed research agencies. Quantitative data are essential for agricultural R&D stakeholders to be able to analyze trends in agricultural R&D investments and capacity; identify gaps; set future investment priorities; and better coordinate agricultural R&D across institutes, regions, and commodities. R&D indicators are also an indispensable tool when assessing the contribution of agricultural R&D to agricultural growth and to economic growth more generally.

This report analyzes input indicators of public agricultural R&D for five South Asian countries (hereafter referred to as South Asia): Bangladesh, India, Nepal, Pakistan, and Sri Lanka.[1] It presents trends and challenges with regard to agricultural R&D investments and human resource capacity throughout the subregion, and provides recommendations for ways to address some of these challenges. The analysis in this report draws largely from a set of country notes prepared by the Agricultural Science and Technology Indicators (ASTI) initiative of the International Food Policy Research Institute (IFPRI) using comprehensive datasets derived from primary surveys covering 2002–09.[2] These new datasets have been linked with historical ASTI datasets for the subregion, thereby allowing a more long-term analysis of public agricultural R&D investment and capacity trends.

Who Are the Main Players in South Asian Public Agricultural R&D?

The landscape of South Asian agricultural R&D is highly complex, comprising a large number of government, higher education, nonprofit, private sector, and international research agencies. The data presented in this report include only public national agricultural R&D. Staff and spending data for private-sector companies and international agricultural R&D agencies operating in the subregion, such as the centers of the Consultative Group on International Agricultural Research (CGIAR), have been excluded (see Box 1 for a more detailed description of private-sector involvement in agricultural R&D).

Over the past two decades, the institutional structure of public agricultural R&D in South Asia has remained largely unchanged. While there have been ongoing internal reorganizations, none of the countries has undertaken fundamental restructuring of its research system, as was common practice throughout the 1960 and 1970s (Beintema and Stads 2008). As of 2009, a total of 372 public agencies were identified as conducting agricultural R&D in South Asia, including 236 government agencies, 132 higher education agencies, and 4 nonprofit agencies.[3] Unsurprisingly, a large degree of variation exists across the sample countries in terms of the size and structure of their agricultural R&D systems. The study identified 167 public agencies conducting agricultural R&D in India, 123 in Pakistan, 54 in Bangladesh, 20 in Sri Lanka, and 8 in Nepal. Despite differences in size and structure, the organization and coordination of national agricultural R&D systems bear some similarities across the five countries: all have national agricultural research councils that coordinate agricultural R&D, set priorities, and administer competitive grant schemes, although their roles and scope of authority vary and in some cases are undergoing change. The specifics relating to each country are discussed in turn below.

India has by far the largest agricultural R&D system in the subregion in terms of staff, expenditures, and number of agencies. The Indian Council for Agricultural Research (ICAR) directly oversees 97 agencies, including 4 "deemed" universities, 45 research institutes, 17 national research centers, 6 national bureaus, and 25 project directorates. The research institutes and national research centers under ICAR primarily focus on research; the project directorates are responsible for the coordination of research conducted by different agencies, including the state agricultural universities (SAUs); while the national bureaus primarily focus on natural resource conservation. The research conducted by ICAR's institutes covers a broad range of areas, including crops, livestock, fisheries, natural resources, agricultural engineering, policy, and management. ICAR institutes vary considerably in size, the largest by far being the Indian Agricultural Research Institute (IARI), followed by the Indian Veterinary Research Institute (IVRI), both of which, together with the National Dairy Research Institute (NDRI) and the Central Institute for Fisheries and Education (CIFE), are classified as "deemed" universities. Researchers from some of the other ICAR institutes serve as faculty staff to nearby SAUs, which are mandated to perform state-specific research and education; were created following on the U.S. land grant system; and comprise multiple faculties focusing on key areas like crops, horticulture, animal science, fisheries, and so on. Many SAUs attract students from across Asia at both the undergraduate and postgraduate levels. The country's largest SAUs include Chaudhary Charan Singh Haryana Agricultural University (HAU), Punjab Agricultural University (PAU), Acharya N. G. Ranga Agricultural University (ANGRAU), and Tamil Nadu Agricultural University (TNAU). A number of other government and higher education agencies are involved in agricultural R&D in India, but their collective shares of total public agricultural R&D remains small. Notably, the Indian Council of Forestry Research and Education (ICFRE) undertakes forestry research related to climate change, biodiversity, desertification, and sustainable management.

In **Pakistan**, the main agricultural R&D agency is the Pakistan Agricultural Research Council (PARC), whose broad mandate is the coordination of research among federal, provincial, and higher education agencies. PARC oversees a number of federal government research agencies located across the country.

One of the largest is the National Agricultural Research Center (NARC), which in turn oversees a number of its own research institutes. Aside from PARC/NARC, 18 other federal government agencies conduct agriculture-related R&D under various ministries. Despite the size and large number of institutes at the federal level, agricultural R&D also falls within the domain of Pakistan's provincial governments. As of 2009, 41 agencies conducted agricultural R&D in the country's four provinces—Punjab, Sindh, Balochistan, and Khyber Pakhtunkhwa. Together, these provincial agencies accounted for more than half of Pakistan's agricultural R&D capacity. With the devolution of agriculture to the provinces in 2010, provincial research systems have gained a clearer mandate in R&D. A key challenge, however, will be to ensure an equitable division of resources and capacities both between the federal agencies and the provinces, as well as among the provinces themselves, given that half of the provincial-level R&D staff are currently located in Punjab Province, a major wheat-growing area. Efforts are underway to strengthen PARC and improve its relevance and effectiveness under the government's new configurations and economic growth priorities. Similar processes are being pursued in light of the government's plans to devolve public universities to the provinces. The role of Pakistan's universities in agricultural R&D has become increasingly important in recent years. Student enrollments in agricultural faculties nearly doubled during 2003–09, and agricultural scientist numbers have also followed a steep upward trend. The University of Agriculture, Faisalabad (UAF) is Pakistan's largest agricultural university.

In **Bangladesh**, the activities of 10 different crop, livestock, forestry, and fisheries research institutes are coordinated by the Bangladesh Agricultural Research Council (BARC). The largest of these institutes are the Bangladesh Agricultural Research Institute (BARI), focusing on a wide range of crops, and the Bangladesh Rice Research Institute (BRRI). The fact that the BARC–affiliated institutes fall under five different ministries has complicated and limited the overall coordinating role of the BARC Secretariat. However, the recently approved BARC Act will address this problem by requiring that BARC coordinates the distribution of funds to the research institutes and approves their R&D programs. Outside of the BARC–affiliated institutes, 10 other government agencies and 32 higher education agencies conduct agricultural R&D in Bangladesh. The higher education agencies also follow the national research priorities set by BARC. Bangladesh Agricultural University (BAU), in particular, has strong research capacity and its number of research projects has been on the rise in recent years.

In **Sri Lanka**, the Sri Lanka Council for Agricultural Research Policy (SLCARP) exercises a high degree of central authority over agricultural research by overseeing and coordinating the activities of all 13 government and 7 higher education agencies involved in agricultural R&D. The bulk of the country's agricultural R&D is carried out by the government sector. Aside from the Department of Agriculture (which oversees institutes involved in rice, horticultural, and food crops research), public R&D is conducted by a number of R&D institutes specializing in plantation crops, as well as institutes focusing on livestock, fisheries, forestry, or postharvest activities. The University of Peradeniya is the country's largest agricultural university.

The vast majority of agricultural R&D in **Nepal** is carried out by the Nepal Agricultural Research Council (NARC), which assists the national government in formulating agricultural policies and conducts research related to crops, livestock, aquaculture, natural resources, postharvest, climate change, agroeconomics and marketing. Tribhuvan University is the country's only university engaged in agricultural R&D. Unlike other countries in the subregion, nongovernmental organizations (NGOs), such as Local Initiatives for Biodiversity, Research and Development (LI-BIRD), play an increasingly important role in agricultural R&D in Nepal. Despite the Nepalese government's commitment to the development of a strong national agricultural research system, the fragile political climate and instability at the Ministry of Agriculture have made long-term R&D planning extremely difficult and decisionmaking processes unclear.

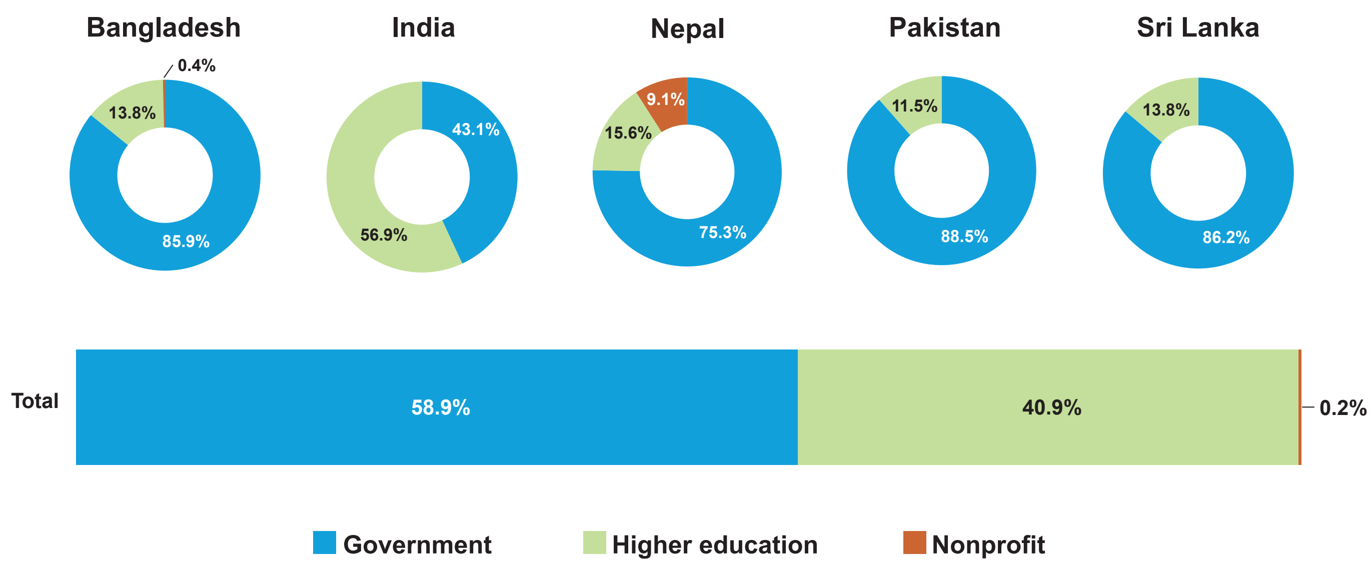
The institutional composition of public agricultural R&D in South Asia has remained relatively unchanged since the mid-1990s. As of 2009, government agencies represented about two-thirds of agricultural R&D capacity in the subregion, while the higher education sector accounted for roughly one-third, and the nonprofit sector for less than 1 percent (Figure 1). These subregional shares mask major cross-country differences. While the government sectors in Bangladesh, Nepal, Pakistan, and Sri Lanka employ the majority of these countries' agricultural researchers, in India the higher education sector dominates in terms of R&D staff numbers: in 2009, universities (mostly SAUs) accounted for 57 percent of Indian agricultural R&D capacity. Nepal is the only country in the subregion where the nonprofit sector plays a significant role in agricultural R&D, representing 9 percent of the country's agricultural research capacity in 2009.

Strengthening Local and International Agricultural R&D Linkages

Historically, agricultural R&D planning in South Asia has operated from the top down, and linkages between agricultural R&D agencies and extension or advisory services have generally been weak. Exceptions do exist where research is successfully embedded in development practice, but on the whole channels for distributing the outputs of public agricultural research to their end users remain poorly developed (Hall and Sulaiman 2008). Nevertheless, the need to improve linkages between agricultural R&D agencies and other organizations is widely recognized across the subcontinent. India's National Agricultural Innovation Programme (NAIP) and Bangladesh's National Agricultural Technology Project (NATP) both have large components devoted to developing research consortia with civil society and private partners. Both programs aim to enhance R&D coordination at the national level and strengthen the coordinating role of the ARCs. The National Agricultural Research Fund (NARDF) in Nepal similarly encourages more diverse participation in research projects, while in Pakistan efforts are underway to strengthen PARC and improve its relevance and effectiveness under the government's new configurations and economic growth priorities.

Awareness of the need for regional and international partnerships in agricultural research has also grown in

Figure 1—Institutional distribution of public agricultural research staff by country, 2009



Sources: Compiled by authors based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes available at www.asti.cgiar.org).

Note: Percentages indicate the respective shares of total public agricultural research staff in 2009 based on full-time equivalent researchers.

recent decades. Networks have proved to be a successful mechanism for helping countries keep pace with global scientific developments and issues. Cross-country collaboration is cost-effective because countries can more rapidly capture technology spillovers across geographic boundaries and reduce research duplication. India, for instance, has a sophisticated national agricultural research system that produces technologies and methods applicable to other countries in the subregion and the rest of the world. Nonetheless, collaborative research across countries on issues of subregional significance is still relatively limited, and initiatives that build and enhance linkages need to be further strengthened in order to maximize possible synergies.

The largest regional initiative active in South Asia is the Asia Pacific Association of Agricultural Research Institutions (APAARI). APAARI is an organization with members comprising national agricultural research

Box 1—The increasing role of the private sector in agricultural R&D in South Asia

Measuring private-sector investments in agricultural R&D is challenging because firms have a strong incentive to withhold this information to prevent competitors from knowing their business strategies. However, recent studies on private agricultural innovation conducted in Bangladesh, India, and Pakistan conclude that the sector is playing an increasingly important role in agricultural R&D, particularly in terms of seed (Naseem et al. 2012; Pray and Nagarajan 2012; Rashid, Ali, and Gisselquist 2012). The primary reasons for the growing involvement of the private sector in agricultural R&D are related to an increased demand for agricultural outputs, as well as the adoption of national policies promoting private-sector engagement in R&D. The increased demand drives firms to invest in R&D in pursuit of technologies that reduce farmers' use of agricultural inputs or increase productivity, thereby increasing efficiency. Government promotion of private-sector involvement, which includes the tightening of intellectual property rights (IPR), increases the profit incentive for firms to develop new technologies. India, for example, has strengthened its IPR regime in harmonization with international agreements to encourage private-sector involvement in agricultural technology development. Furthermore, ICAR has put in place IPR guidelines geared to stimulating innovation by sharing research benefits with innovators. These guidelines are useful in fostering partnerships with the private sector to facilitate scaling up and commercializing technologies developed by the public sector.

In India, private-sector spending has more than quadrupled since the mid–1990s. In 2008/09, the private sector invested a total of 531 million purchasing power parity, or PPP, dollars (in 2005 constant prices), accounting for close to one-fifth of India's total public and private agricultural R&D investments that year.[a] The country's private-sector agricultural R&D capacity has also grown rapidly. In 2004/05 (the latest year for which data are available), the number of private-sector R&D personnel reached 2,470 full-time equivalents compared with 710 recorded in 1992/93 (Pray and Nagarajan 2012). Bangladesh's private-sector agricultural R&D spending has also increased rapidly in recent years, especially in the country's seed sector (Rashid, Ali, and Gisselquist 2012). Similarly, a recent study in Pakistan found that the average seed company invested 5.5 percent of its sales in R&D (Naseem et al. 2012). The same survey found sizable private involvement in the fertilizer sector, but private R&D investment by the livestock, irrigation, and processing subsectors were found to be nominal.

In the foreseeable future, the public sector will continue to dominate agricultural R&D in South Asia; however, the private sector has demonstrated its ability to successfully increase agricultural productivity and has tremendous potential to commercialize technologies developed by the public sector. Governments should therefore continue to create policies that incentivize private-sector enterprises to invest in R&D and develop synergies to leverage collaboration between the public and private sectors.

[a]This figure does not include investment in food processing for reasons associated with international comparisons (official agricultural GDP figures also exclude food processing). Were the food processing subsector included, total private agricultural R&D spending in India would increase to nearly 700 million PPP dollars (in 2005 prices).

organizations from across the Asia–Pacific region, including the five South Asian agricultural research councils. APAARI's main focus is on organizing research networking and regional planning meetings, and providing linkages to international organizations, including the centers under the CGIAR. Over the years, APAARI has successfully promoted spillovers of technical and institutional innovations throughout the subregion, together with the sharing of country experiences.

The mandate of the South Asian Association for Regional Collaboration (SAARC) includes, among other things, enhancing agricultural R&D collaboration across the subregion. SAARC's Agriculture Centre, which is located at the BARC complex in Dhaka, Bangladesh, serves as a platform for sharing knowledge on the latest scientific breakthroughs related to agriculture, fisheries, livestock, forestry, and allied subjects of concern for researchers, extension agents, and policymakers in member countries.

The CGIAR plays an important role in South Asia. Two of its centers are headquartered in the subcontinent—the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, India, and the International Water Management Institute (IWMI) in Battaramulla, Sri Lanka—and many other CGIAR centers run offices at the ICAR complex in New Delhi. The scope of the CGIAR's activities in South Asia is broad. Most of the centers have a long-established experience in managing regional crop and livestock networks, running regional projects, and collecting and improving germplasm. A good example of successful collaboration between national R&D agencies and the CGIAR is the so-called Rice–Wheat Consortium, which was established in 1994 by the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT), and the agricultural research councils of Bangladesh, India, Nepal, and Pakistan. The consortium addresses sustainability issues of intensively cultivated and irrigated cropping systems in the semi-arid regions of the subcontinent on partnership with NGOs, the private sector, farmer organizations, and a number of other CGIAR centers.

Various other international organizations, such as the World Vegetable Center (AVRDC), have a presence or conduct agricultural research in South Asia. Staff and expenditure levels of these international centers are excluded from the analysis of this report because its focus is national-level investments and capacities.

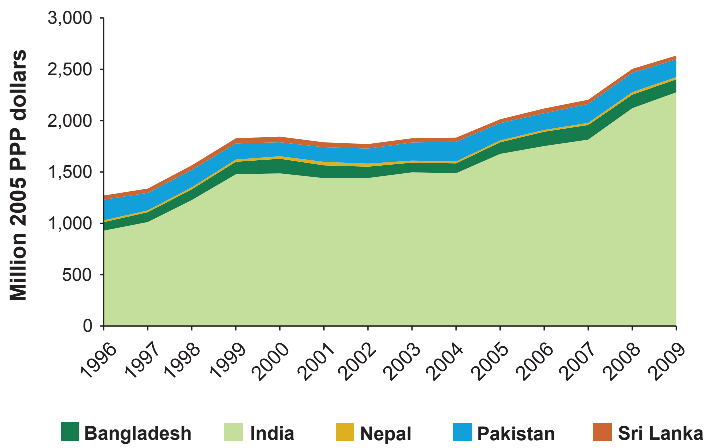
Public Agricultural Research Spending

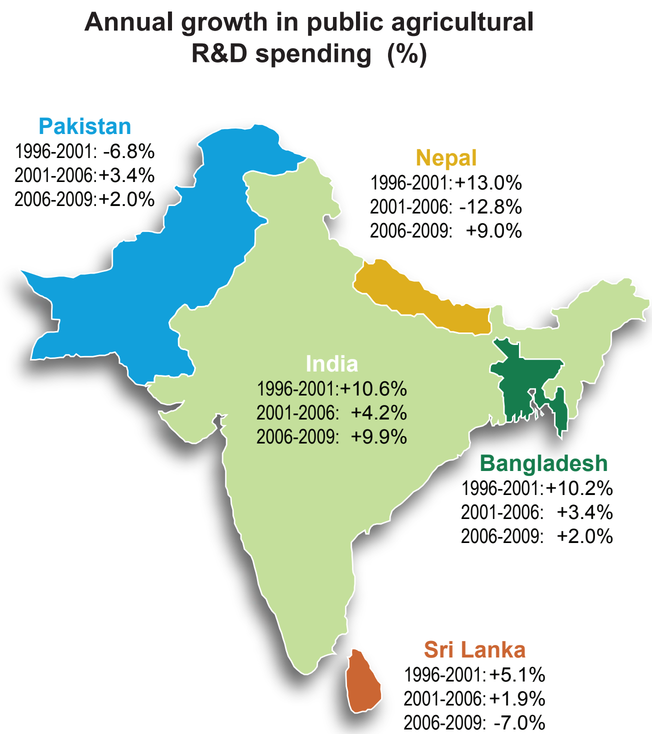
Investment Levels across Countries

In 2009, public agricultural investments in South Asia totaled $2.6 billion in inflation-adjusted purchasing power parity (PPP) dollars, or $877 million in 2005 constant U.S. dollars (Figure 2), which includes salaries, operating and program costs, and capital investments (see Box 2, page 8, for an explanation of PPP dollars). These expenditure levels represent a marked increase compared with previous years, and this growth was almost entirely driven by the subregion's largest country, India.

In 1996, India's public spending totaled $0.9 billion (in 2005 PPP prices). After a period of strong growth in the late-1990s, the country's yearly growth in agricultural R&D expenditures stagnated during 1999–2004, in line with more general stagnation of the nation's agricultural sector. After 2004, however, India's agricultural R&D spending strengthened due to enhanced government support, such that by 2009 national investments totaled $2.3 billion (in 2005 PPP prices), the second highest

Figure 2—Trends in public agricultural research spending, 1996–2009





Total public agricultural R&D spending
(in million 2005 PPP dollars)

1996		2003		2009	
Bangladesh:	83	Bangladesh:	94	Bangladesh:	126
India:	929	India:	1,497	India:	2,276
Nepal:	18	Nepal:	20	Nepal:	22
Pakistan:	201	Pakistan:	176	Pakistan:	172
Sri Lanka:	40	Sri Lanka:	42	Sri Lanka:	38
TOTAL:	**1,271**	**TOTAL:**	**1,829**	**TOTAL:**	**2,634**

Sources: Compiled by authors based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes available at www.asti.cgiar.org).

Notes: All expenditures are expressed in 2005 PPP dollars. Compound yearly growth rates are calculated using the least-squares regression method. Further information on ASTI's data methodology and calculation procedures is provided on ASTI's website (www.asti.cgiar.org/methodology).

Box 2—Measuring agricultural R&D resources

Purchasing power parities (PPPs) as the preferred measure of R&D investments

Comparing R&D data is a highly complex process due to important differences in price levels across countries. The largest components of a country's agricultural R&D expenditures are staff salaries and local operating costs, rather than internationally traded capital investments. For example, the wages of a field laborer or a laboratory assistant at a research facility are much lower in Pakistan than they are in any European country; similarly, locally made office furniture in Bangladesh will cost a fraction of a similar set of furniture bought in the United States.

Standard market exchange rates are the logical choice for conversions when measuring financial flows across countries; however, they are far from perfect currency converters for comparing economic data. At present, the preferred conversion method for calculating the relative size of economies, or other economic data such as agricultural R&D spending, is the purchasing power parity (PPP) index. PPPs measure the relative purchasing power of currencies across countries by eliminating national differences in pricing levels for a wide range of goods and services. They are also used to convert current GDP prices in individual countries to a common currency. In addition, PPPs are relatively stable over time, whereas exchange rates fluctuate considerably (for example, the fluctuations in the U.S. dollar–euro rates of recent years).

The concept of full-time equivalent (FTE) researchers

ASTI bases its calculations of human resource and financial data on full-time equivalent staffing, or FTEs, which take into account the proportion of time that researchers spend on R&D activities. University staff members, for example, spend the bulk of their time on nonresearch-related activities, such as teaching, administration, and student supervision, which need to be excluded from research-related resource calculations. As a result, four faculty members estimated to spend 25 percent of their time on research would individually represent 0.25 FTEs and collectively be counted as one FTE.

Source: ASTI website (www.asti.cgiar.org/methodology).

level in the developing world (see Box 3, page 13). The government's strong commitment to agricultural R&D has been rewarded with high economic and social returns to research investments, and government funding is expected to increase further in the coming years.

The combination of strong growth in Indian agricultural R&D spending, coupled with slower and more volatile growth in the remaining four South Asian countries, further emphasizes India's role in the subregion. In the mid-1990s, India accounted for 73 percent of South Asia's agricultural R&D expenditures, whereas this share had risen to 86 percent by 2009. Pakistan accounted for 7 percent of agricultural R&D expenditures in 2009, followed by Bangladesh (5 percent), Sri Lanka, and Nepal (1 percent each). In 2009, Bangladesh, Nepal, Pakistan, and Sri Lanka spent a combined $358 million of a subregional total of $2.6 billion (in 2005 PPP prices).

Although the rapid increase in Indian agricultural R&D spending in recent years overshadows the trends occurring in the subcontinent's smaller countries, an examination of relative shifts in investment levels over time reveals some interesting cross-country and cross-institutional differences and challenges. In Bangladesh, agricultural R&D spending has shown an upward, though erratic, trend since the mid-1990s. Before the turn of the millennium, increased government contributions and project-related funds derived from the World Bank loan–funded Agricultural Research Management Project (ARMP) led to a rapid increase in the country's spending levels. The completion of the World Bank project caused public expenditures on agricultural R&D to fall by more than one-third during 2000–03, but expenditures quickly recovered in subsequent years. During 2007–09, agricultural R&D spending levels once again declined. The 2009 launch of the National Agricultural Technology Project (NATP), financed by the national government, the World Bank, and the International Fund for Agricultural Development (IFAD), will likely reverse this trend again in the coming years. In 2009, Bangladesh invested 126 million purchasing power parity (PPP) dollars (in 2005 constant prices).

Agricultural R&D spending in Nepal is characterized by severe year-to-year fluctuations, largely linked to the influx of donor funding. The completion of World Bank loan–financed Agricultural Research and Extension Project (AREP), which ran from 1998 to 2002, led to a sharp decline in agricultural R&D investment levels. Although spending rebounded somewhat after the 2006 signing of the Comprehensive Peace Accord due to increased government support for public agricultural R&D, levels remain below those recorded around the turn of the millennium. In 2009, the country spent $22 million on agricultural R&D (in constant 2005 prices).

Public agricultural R&D spending in Pakistan fluctuates considerably from year to year. After an erratic downward trend in the 1990s, spending levels increased after the turn of the millennium, albeit erratically. In 2009, investment in public agricultural research totaled $172 million (in 2005 constant prices). A relatively small proportion this amount was channeling into the costs of operating R&D programs or into much-needed infrastructure.

In the late-1990s, Sri Lankan agricultural R&D spending levels rose rapidly, particularly for the research institutes focusing on plantation crops, whose research was funded through commodity levies. In subsequent years, revenues generated by these levies were gradually channeled away from research activities, so the country's overall R&D spending levels declined. Moreover, the worsening security situation forced the government to allocate an increasing share of public resources toward national security at the expense of other priorities, including agricultural R&D. Consequently, during 2000–09 agricultural R&D spending in Sri Lanka fell by roughly one-third, and in 2009 totaled $37.5 million (in constant 2005 prices).

In addition, a closer consideration of the allocation of agricultural R&D expenditures across cost categories reveals some major differences across countries. In Pakistan, for example, nearly three-quarters of PARC's 2009 expenditures were allocated to salaries, whereas NARC spent 93 percent of its expenditures on salaries that year. Salaries also accounted for the bulk of spending in other federal and provincial agencies in the country. The very high shares of expenditures on salaries across agencies in Pakistan leaves minimal funding for the operating costs associated with research, let alone the maintenance and upgrading of fundamental infrastructure. Given the dependence by many federal agencies on donors funding to support research activities, longer term capital investments tend to be overlooked. This contrasts sharply with the situation in Bangladesh; in 2009, of the combined expenditures of the BARC–affiliated agencies, salaries accounted for just 39 percent, operating expenses for 40 percent, and capital investments for 21 percent. By comparison in Nepal that year, NARC spent 53 percent of its research budget on salaries and just 5 percent on capital investments. Unfortunately, comprehensive cost category data were not available for India or Sri Lanka.

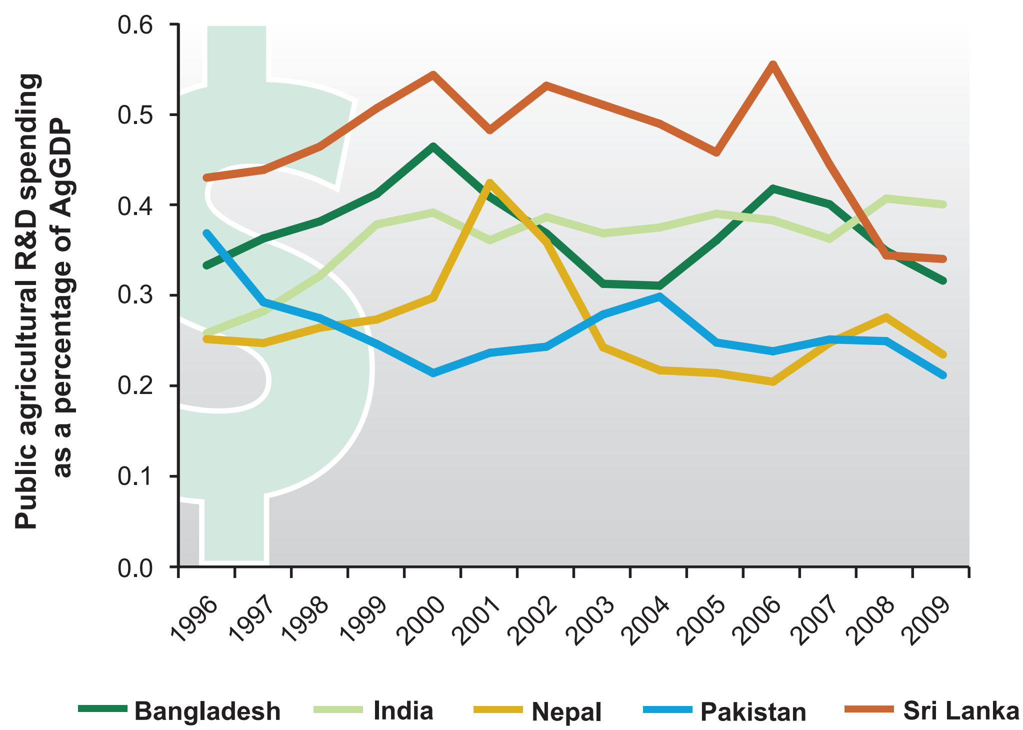
Intensity of Public Agricultural R&D Spending

Analyzing absolute levels of research expenditures explains only so much. Another way of comparing the commitment to public agricultural R&D investments across countries is to measure total public agricultural R&D spending as a percentage of agricultural gross domestic product (AgGDP). This relative measure goes beyond absolute agricultural R&D spending levels to indicate the intensity of investments. On average, in 2009 South Asia invested $0.37 in agricultural research for every $100 of agricultural output, up from $0.28 in 1996 (Figure 3, page 10). In comparison, in 2008 Sub-Saharan Africa invested $0.61 in agricultural research for every $100 of agricultural output, and in 2006 Latin America and the Caribbean invested $1.14 in agricultural research per $100 of agricultural output (Stads and Beintema 2009; Beintema and Stads 2011). Unsurprisingly, the South Asia–wide averages are largely driven by India and mask a significant degree of cross-country variation. With an intensity ratio of 0.40 percent in 2009, India's agricultural R&D investments as a share of agricultural output were almost twice those of Pakistan (0.21 percent) and Nepal (0.23 percent), and also substantially higher than those of Bangladesh (0.31 percent) and Sri Lanka (0.34 percent).

As previously mentioned, agricultural R&D spending in Bangladesh, Nepal, Pakistan, and Sri Lanka was characterized by a larger degree of volatility from the mid-1990s compared with India. This is also reflected in these countries' agricultural R&D intensity ratios. While India's agricultural R&D intensity ratio increased steadily during 1996–2009, ratios among its neighbors developed more erratically. Sri Lanka's intensity ratio, for example, dropped by almost 40 percent during 2006–08 due to a decrease in the country's agricultural R&D expenditure levels coupled with an increase in agricultural output. Similarly, the completion of the World Bank–financed AREP in Nepal in 2002 caused a severe plunge in the country's intensity ratio. It should be noted, however, that although these ratios are useful on face value for comparative purposes, they fail to take into consideration the policy context and institutional environment of a country's agricultural R&D system.

India's 12th five-year plan for the period 2012–17 set an agricultural R&D intensity target of 1 percent of AgGDP, but some argued that this was still insufficient, leading to a call for a 2 percent target, which has been approved, in principal, by the national government. Similarly, the National Agricultural Research Plan (NARP) in Sri Lanka outlined an agricultural R&D investment target of 1.5 percent of AgGDP, while the Government of Nepal approved the Nepal Academy

Figure 3—Intensity of public agricultural R&D spending, 1996—2009



Sources: Compiled by authors based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes available at www.asti.cgiar.org); AgGDP data are from World Bank 2012b.

Note: Intensity ratios for Bangladesh and Nepal differ slightly from those published in the ASTI country notes because of recent World Bank revisions to its GDP deflators.

of Science and Technology (NAST) recommendation that 1 percent of Nepal's GDP be invested in S&T. Achieving such ambitious targets will depend on firm financial and political commitments from national governments in the coming years. Given the current low intensity ratios in these three countries, agricultural R&D spending would need to more than quadruple in the coming years to meet the targets (assuming that agricultural output remains unchanged). Considering recent investment trends, the current targets seem unrealistic. A more attainable first step would be achieving the targets defined in the 2009 Bangkok Declaration—endorsed during APAARI's Expert Consultation on Agricultural Research for Development in Asia and the Pacific—which call for a doubling of agricultural R&D spending throughout the region. Simply doubling, tripling, or quadrupling investments should not be misconstrued as the end goal, however. The real goals are to ensure that R&D agencies have the necessary human, financial, operating, and infrastructural resources to effectively and efficiently develop, adapt, and disseminate S&T innovations within an appropriate enabling public policy environment in order to maximize their impact on the agriculture sector, on rural and economic development more generally, ultimately reducing poverty and hunger.

Funding Sources of Public Agricultural R&D

Funding for public agricultural R&D in South Asia is derived from a variety of sources, including national and state governments, donors, development banks, producer organizations, and the private sector, along with internally generated revenues through the sale of goods and services. Unfortunately, the available data did not allow for a detailed analysis of funding trends across all five countries over time. The data did, however, reveal that governments remain by far the most important source of funding for public agricultural R&D in the subregion. Donors and development banks play a relatively more important role in funding agricultural R&D in Bangladesh, Nepal, and Pakistan than in India and Sri Lanka, but overall, agricultural R&D agencies in South Asia are less dependent on donor and development bank funding than their counterparts in other low- and lower middle-income regions, such as Sub-Saharan Africa or Central America. All five South Asian countries have implemented competitive grant schemes for agricultural R&D, often as part of projects financed through World Bank loans or by donors. Nevertheless, many of these competitive funds have faltered with the completion of the project being funded, raising questions as to the long-term sustainability of this kind of funding mechanism. With the exception of the SAUs in India, agricultural R&D funding for higher education agencies is largely spotty and ad hoc. Given that teaching is the core business of most agricultural faculties across South Asia, dedicated R&D budgets at agricultural faculties are rare. A more detailed description of national funding trends since the turn of the millennium is provided below.

In **Bangladesh**, the BARC–affiliated agencies receive funding primarily from government sources, either on a recurring basis or through the Annual Development Program (ADP). The World Bank loan–funded NATP also plays an important role in financing public agricultural R&D. Founded as a component of NATP, the Krishi Gobeshona Foundation (KGF) is a competitive grant initiative that funds agricultural R&D projects of two years' duration or less. IRRI has played an important role in funding capacity building for rice research in Bangladesh. The higher education agencies receive no direct government support for research purposes; the University Grants Commission (UGC) allocates funding for training, equipment, and some research activities. Donors like the United States Department of Agriculture (USDA) and the European Commission have supported large R&D projects at BAU.

In **India**, public agricultural R&D is largely funded by the federal government through ICAR. In addition, a significant portion of ICAR's resources are channeled to the SAUs as development grants and funds for coordinated and on-farm research. Some agricultural R&D agencies in India also generate funds internally by commercializing technologies and providing contract-based research and services. World Bank loans have played an important role in funding Indian agricultural R&D in recent years through two consecutive projects: the National Agricultural Technology Project (NATP, 1998–2005) and NAIP (since 2006). A small portion of NATP and NAIP funds were used for competitive grant schemes. Competitive funds are also provided by the Department of Science and Technology (DST) and the Department of Biotechnology (DBT). Other donors, including the Australian Centre for International Agricultural Research (ACIAR) and the U.K. Department for International Development (DFID), have also funded agricultural R&D activities in India.

In **Nepal**, NARC received substantial funding through the World Bank–financed Agricultural Research and Extension Project (AREP), which ran from 1998 to 2002. When AREP ended, the Nepal government increased its support for NARC; however, this government funding is mainly allocated to salaries, compelling researchers to seek external funding for their research activities. In contrast to government agencies, agricultural R&D at Nepal's NGOs is almost entirely funded by foreign donors. NARDF is a competitive grant scheme for agricultural R&D that was founded in 2001. It was largely funded by DFID and the Asian Development Bank (ADB) until 2009, but it has been funded solely by the government since. NARDF funds around 20 to 25 projects per year, and prioritizes collaborative proposals between government agencies, NGOs, and the private sector.

In **Pakistan**, PARC and the other federal agencies receive funding from a variety of donors, but only a small proportion is channeled to the provincial institutes. With salaries largely supported by recurrent government funding, donor and internally generated funding have made a significant contribution to the operating and capital costs of the country's research. Two major government programs have been implemented in recent years. Since 2000, the Agricultural Linkages Program (ALP) with its funding mechanism, the Agricultural Research Endowment Fund (AREF), finance research in a number of priority areas. The Research for Agricultural Development Program (RADP) began in 2007 and has funded R&D under 22 priority areas across similar research themes as ALP. In addition, the Pakistan Science Foundation provides competitive research funds for projects in the agricultural sciences and offers fellowships for PhD programs. Various other government agencies run competitive grant schemes for agricultural research, including the Punjab Agricultural Research Board at the provincial level.

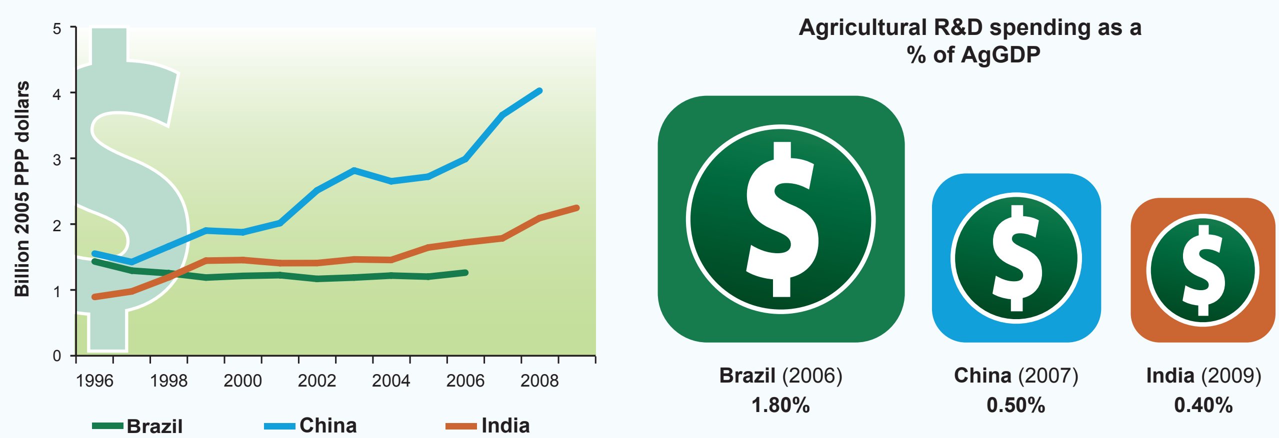
In **Sri Lanka**, the SLCARP institutes are largely funded by the national government, supplemented with a few research grants from local and international sources. The institutes under the Ministry of Plantations used to receive large amounts of funding through levies imposed on the import and export of plantation crops, of which a proportion was directly allocated to R&D. Since 2006, however, the revenues generated by these levies are channeled through the Treasury and the share allocated to R&D has declined. Compared with the SLCARP institutes, agricultural research at Sri Lanka's universities is more dependent on donor funding. The World Bank–initiated Competitive Contract Research Program (CCRP) was an important funding source for Sri Lankan agricultural research during 1989–2006. In 2011, a new funding scheme was established by the World Bank as part of NARP, which essentially took the place of CCRP. Seventy projects were financed during the first year of the scheme.

Box 3—Public Agricultural R&D Spending in India within a Global Context

Brazil, China, and India have all emerged as economic powerhouses in the global agricultural economy. Combined public agricultural R&D investments by these three countries account for about half of all investments in agricultural R&D in the developing world (excluding Eastern Europe and former Soviet states) and represented a significant increase over their 1981 share of just 35 percent (Beintema and Stads 2010).

During 2000–08, China's public agricultural research spending more than doubled from $1.9 to $4.0 billion (in 2005 prices) (Figure 4). Policy reforms supporting the establishment of a patent system combined with the diversification of funding sources through commercialization and competition greatly contributed to this spending boost (Chen, Zhang, and Flaherty 2012). Brazil has traditionally had one of the most advanced and well-funded agricultural research systems in the developing world. Although Brazil's agricultural R&D spending ($1.3 billion in 2006) is much lower than China's in absolute terms, it is high relative to the size of the country's population and agricultural economy (Figure 4). In India, absolute spending levels grew steadily during 2000–08, faster than in Brazil, but more slowly than in China. In 2009, the country invested $2.3 billion (in 2005 prices) on agricultural R&D, which corresponds to $0.40 for every 100 dollars of AgGDP. While this was the highest intensity ratio in South Asia that year, it was lower than China's 2008 level of $0.50 and just a fraction of Brazil's 2006 level of $1.80. Despite rapid growth in agricultural R&D spending in China and India since the turn of the millennium, both countries have a long way to go to catch up, in relative terms, with Brazil.

Figure 4—Trends in public agricultural R&D spending in Brazil, China, and India, 1996–2009



Sources : Calculated by authors based on ASTI datasets (various years); Beintema, Avila, and Fachini 2010; and Chen, Flaherty, and Zhang 2012.

Notes: See individual ASTI country notes for more detailed information on estimation and calculation procedures. The most recent data available for Brazil and China were for 2006 and 2008, respectively.

Human Resources in Public Agricultural Research

Human Resource Capacity and Qualification Levels

In 2009, close to 18,000 full-time equivalent (FTE) agricultural researchers were active in South Asia (see Box 2, page 8, for an explanation on FTEs). With 11,217 FTEs, India accounted for 63 percent of this total (Figure 5). Employing 3,532 FTEs in 2009, Pakistan had the second-highest agricultural R&D capacity in the subregion, followed by Bangladesh (2,081 FTEs), Sri Lanka (619 FTEs), and Nepal (389 FTEs). The number of agricultural researchers in India fell by 8 percent between 2000 and 2009, largely as a result of declining capacity at the SAUs. Although the actual number of SAUs has expanded in recent years with the upgrading of existing campuses, the number of scientists employed has not increased in tandem. Moreover, R&D budgets at SAUs are much lower than those at ICAR. The multidisciplinary nature of SAUs is also diminishing, as some of the newly established SAUs specialize in areas such as animal science, horticulture, or fisheries.

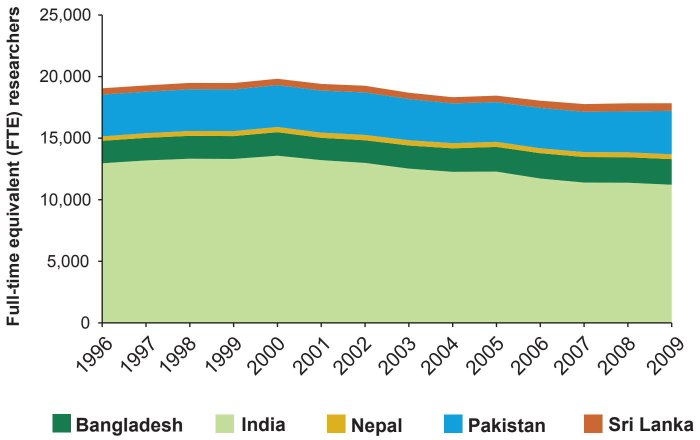
Total agricultural R&D numbers in Pakistan have remained relatively stable over time, although a shift from the provincial level to the federal and higher education levels was recorded. In Bangladesh, agricultural R&D numbers steadily increased during 2000–08, but a large number of vacancies remained at the BARC–affiliated agencies after the exodus of 400 PhD-qualified scientists in the late-1990s and early 2000s for better remunerated positions in Australia, Canada, the United States, or CGIAR centers. The number of agricultural FTE researchers in Sri Lanka rose by 20 percent between 2000 and 2009, although many of these new scientists were not given official research positions due to recruitment restrictions and as such don't qualify for the salary levels, training opportunities, or other benefits afforded to researchers. Nepal's agricultural R&D capacity, on the other hand, steadily declined after the turn of the millennium, largely due to the combined effect of a long-term hiring freeze and the loss of scientists seeking better opportunities abroad. In 2011, NARC had more than 400 vacancies for scientists and technical officers. Part of this challenge stems from the fact that Nepal's government sector is unable to offer competitive salary packages. NARC has recruited 70 BSc-level scientists since 2010, easing some of its acute capacity challenges. Training and mentoring these newly recruited scientists will be a major priority in the coming years, as a significant proportion of NARC's senior scientists are approaching retirement age.

Comparing FTE researcher numbers with the economically active agricultural population provides an indicator of the relative concentration of agricultural R&D capacity across countries. Large differences were observed across countries and over time. Ratios in India, Nepal, and Pakistan gradually declined from the mid-1990s, whereas some improvements were observed in Bangladesh and Sri Lanka in recent years (Table 1). During 2006–09, Sri Lanka and Pakistan employed over four times as many researchers per million farmers compared with Nepal and more than three times as many as in India. Although these ratios provide useful insights their limitations should be noted given that they take neither qualification levels nor experience of research staff into consideration.

The definition of what constitutes a researcher in South Asia differs both across countries and among institutes within countries, making is difficult to draw meaningful cross-country comparisons of human resource capacity. In India, for example, an entry-level researcher at ICAR or the SAUs requires at least a MSc degree, whereas researchers at the ARCs in the other four South Asian countries only require a BSc degree. Moreover, a large number of PhD-qualified researchers in India are employed as technicians rather than as researchers at ICAR, so it is important to include these staff members in any assessment of overall agricultural research capacity.

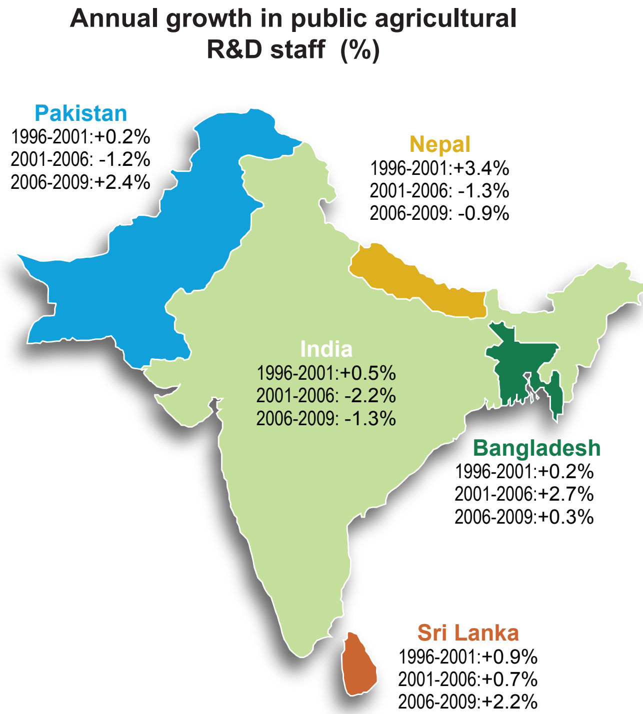
Unfortunately, detailed degree-level data for professional staff at the SAUs and other Indian R&D agencies were not available; however, the ICAR data provides a clear indication that India's agricultural R&D

Figure 5—Staffing trends in public agricultural research by country, 1996–2009



Total public agricultural R&D staff
(in full-time equivalents)

1996		2003		2009	
Bangladesh:	1,825	Bangladesh:	1,880	Bangladesh:	2,081
India:	12,961	India:	12,525	India:	11,217
Nepal:	357	Nepal:	425	Nepal:	389
Pakistan:	3,398	Pakistan:	3,346	Pakistan:	3,532
Sri Lanka:	511	Sri Lanka:	513	Sri Lanka:	619
TOTAL:	**19,052**	**TOTAL:**	**18,688**	**TOTAL:**	**17,837**



Sources: Compiled by authors based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes available at www.asti.cgiar.org).

Note: Compound yearly growth rates are calculated using the least-squares regression method. Further information on ASTI's data methodology and calculation procedures is provided in Box 2 and at ASTI's website (www.asti.cgiar.org/methodology).

Table 1—Number of FTE agricultural researchers per million economically active agricultural population by country, 1996–2009

Country	1996-2000	2001-2005	2006-2009
Bangladesh	59.2	58.3	63.9
India	56.6	50.9	43.6
Nepal	47.7	43.9	35.4
Pakistan	192.3	165.7	144.4
Sri Lanka	143.8	139.7	156.5

Sources: Compiled by authors based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes available at www.asti.cgiar.org); data on economically active agricultural population are from FAO 2012.

staff is significantly more qualified than their colleagues in the other countries. In 2009, ICAR employed 2,282 FTE scientists with PhD degrees, representing 86 percent of the institute's total research staff (Figure 6). ICAR and the SAUs also employ a large number of support staff that assist scientists both in the laboratories and on experiment farms. Most of these support staff hold MSc degrees, but some hold PhD degrees. As of 2009 the ICAR agencies employed nearly 6,000 support staff, and the SAUs some 3,000.

Due in part to these differences in classifications, the four other South Asian countries reported significantly lower shares of PhD-qualified scientists compared with India. In 2009, 29 percent of Bangladesh's agricultural scientists were qualified to the PhD level, as were 23 percent of Sri Lanka's, 20 percent of Nepal's, and 18 percent of Pakistan's. Professional staff employed at the universities in these four countries were considerably more qualified than their colleagues at government agencies: 46 percent of agricultural scientists employed at the higher education agencies held doctorate degrees in 2009, compared with just 19 percent of staff at the government agencies.

From 2003, overall shares of postgraduate (MSc- and PhD-qualified) scientists increased gradually in Bangladesh, Nepal, and Pakistan, but decreased in Sri Lanka due to a large influx of young—in many cases newly graduated—BSc-qualified scientists. Opportunities for formal degree training in South Asia have become more limited than in previous decades. In Nepal, the national government offers approximately 10 scholarships for postgraduate training at Tribhuvan University each year. In addition, about 20 NARC scientists secure independent grants each year for degree-level training abroad. IRRI has also funded PhD training for NARC scientists in recent years. In Pakistan, the majority of scientists were trained during the 1980s and 1990s as part of the World Bank–financed Agricultural Research Project. Training opportunities waned with the completion of that project in 1998, but new initiatives have emerged more recently. The Chief Minister of Punjab, for example, recently announced that 300 scholarships for UAF students (valued at 3 billion Pakistani rupees) would be made available for overseas PhD training through the Punjab Educational Endowment Fund (PEEF). In Sri Lanka, 82 agricultural scientists received MSc training and 41 received PhD training through SLCARP's collaboration with ICAR during 2000–10, but these opportunities have ceased due to lack of funding. Overall, SLCARP lacks a coherent strategy for its long-term training needs. In contrast,

Figure 6—Share of PhD-qualified research staff in official research positions by country, 2009

Source: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes available at www.asti.cgiar.org).

Note: Data on degree qualifications of Indian researchers employed at non–ICAR agencies were not available.

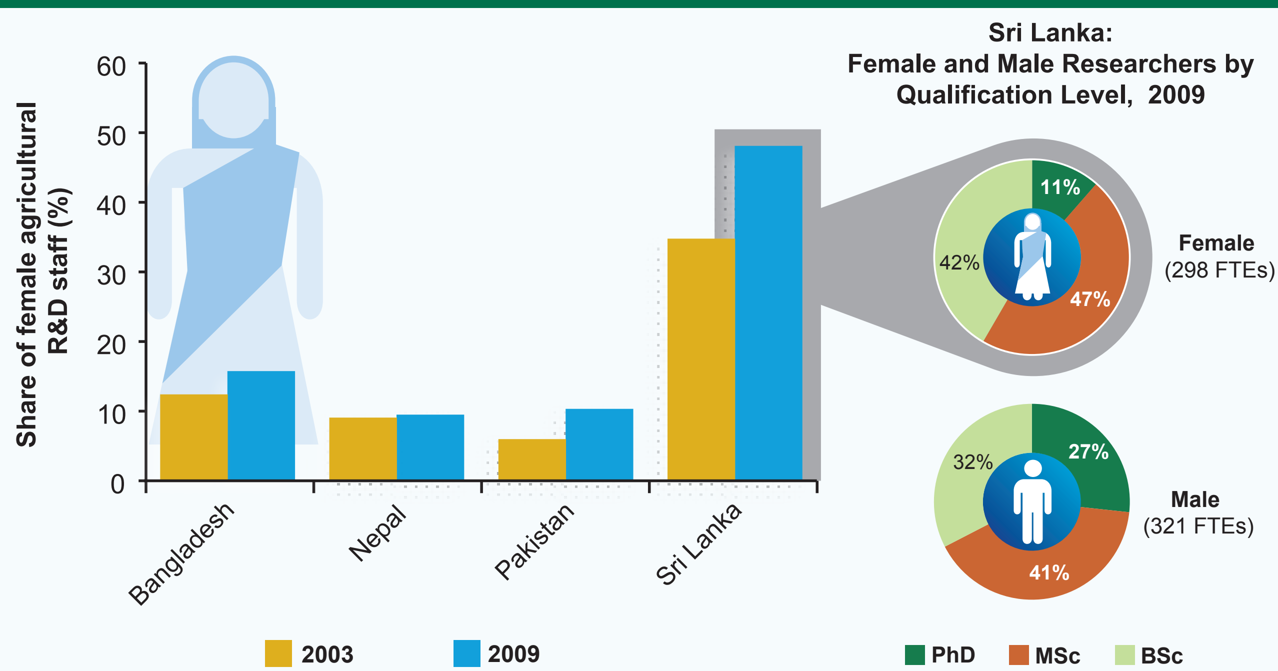
Box 4—Female participation in Agricultural R&D in South Asia

Although women represent roughly 40 percent of the agricultural workforce in South Asia, their roles, status, and ability to participate in decisionmaking processes are often limited (Quisumbing and Pandolfelli 2008). Given women's roles within families, rural households, and communities, it is important that their priorities and concerns are heard and incorporated into development initiatives. Female researchers, professors, and research managers offer unique insights, perspectives, and skills that can help research institutions more effectively address the specific challenges of female farmers in South Asia.

Although gender data were not available for India, evidence from the four other countries indicate that women are severely underrepresented in agricultural R&D in South Asia. In 2009, just 10 percent of agricultural scientists in Nepal and Pakistan were women, as were only 16 percent of scientists in Bangladesh (Figure 7). Interestingly, at 48 percent, the share of female agricultural researchers in Sri Lanka—in sharp contrast to its neighbors—is one of the highest in the developing world. On the positive side, all four countries increased their shares of female scientists in agricultural research in recent years. From a global perspective, however, the overall share of female agricultural researchers in South Asia (excluding India) is extremely low: on average, women constituted 22 percent of agricultural researchers in Sub-Saharan Africa in 2008 and 34 percent in Latin America in 2006 (Beintema and Stads 2011; Stads and Beintema 2009).

In addition to being underrepresented in South Asian agricultural research, women are also less well-qualified than their male colleagues. Aggregating the data for the four South Asian countries, 18 percent of all female scientists held PhD degrees in 2009, compared with 24 percent of all male scientists. Even in Sri Lanka, where significant advancements in gender equality have been made, female scientists are far less likely to hold PhD degrees than their male colleagues. As a result, South Asia still has a long way to go in ensuring female participation agricultural R&D and integrating gender perspectives into the formulation of related policies.

Figure 7—Distribution of researchers by degree qualification and gender in four countries, 2003 and 2009



Source: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes available at www.asti.cgiar.org).

Note: Data on researchers by gender were not available for India.

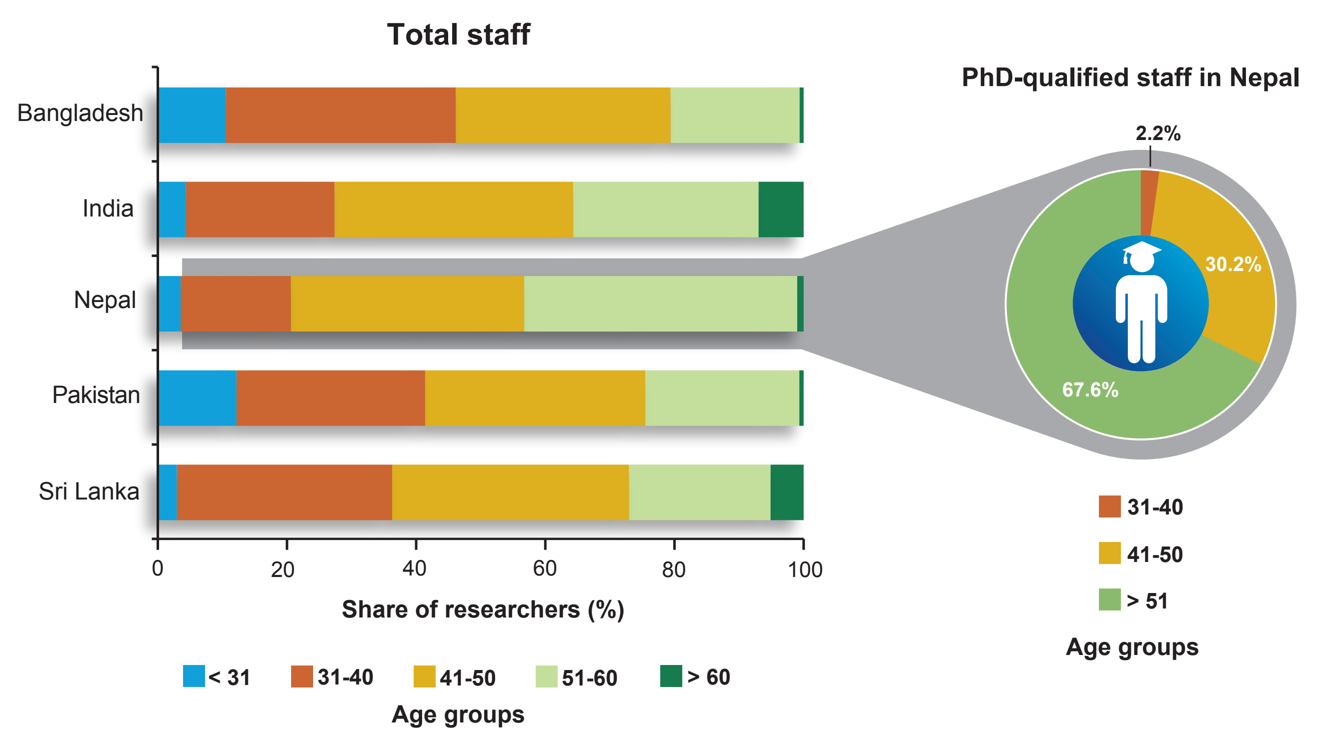
BARC in Bangladesh prepared a human resource development plan as part of NATP to assess the present strength of its research staffing and determine its training needs for 2009–25. Since 2005, BARC has led the organization of an in-country PhD training program that has been funded by the national government, and as a result the number of PhD-qualified scientists in Bangladesh has gradually increased. At BARI, for example, the number of PhD-qualified scientists rose from 106 FTEs in 2003 to 159 in 2009.

A large number of senior agricultural scientists across South Asia were educated in Australia, Europe, or the United States. Given the increasing number of South Asian universities offering PhD training, most of the younger researchers received their degrees from universities either in the subregion or in other Asian countries. Undertaking training within the region is advantageous because it ensures relevance to local conditions, significantly reduces costs, and minimizes the risk that trainees will remain abroad rather than returning home when they complete their studies. Some, however, argue that the overall quality of postgraduate training in the subregion is lower than in the developed world, so the shift toward local training could have a negative impact on future agricultural R&D capacity.

Age Distribution of Agricultural Researchers

Quantitative data on the distribution of agricultural scientists by age are an important input into the R&D planning process. For example, having too many senior researchers approaching retirement age can jeopardize the continuity of future research, whereas a preponderance of young, inexperienced researchers can negatively affect the quality of research over time.[4] It is therefore important that agricultural R&D agencies minimize age imbalances among their research staff

Figure 8—Age distribution of agricultural research staff, 2009



Source: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes available at www.asti.cgiar.org).

Notes: Data on research staff by age were available for 61 ICAR agencies, which together accounted for 69 percent of ICAR's total research staff in 2009; data on research staff by age for agencies in India other than ICAR were not available.

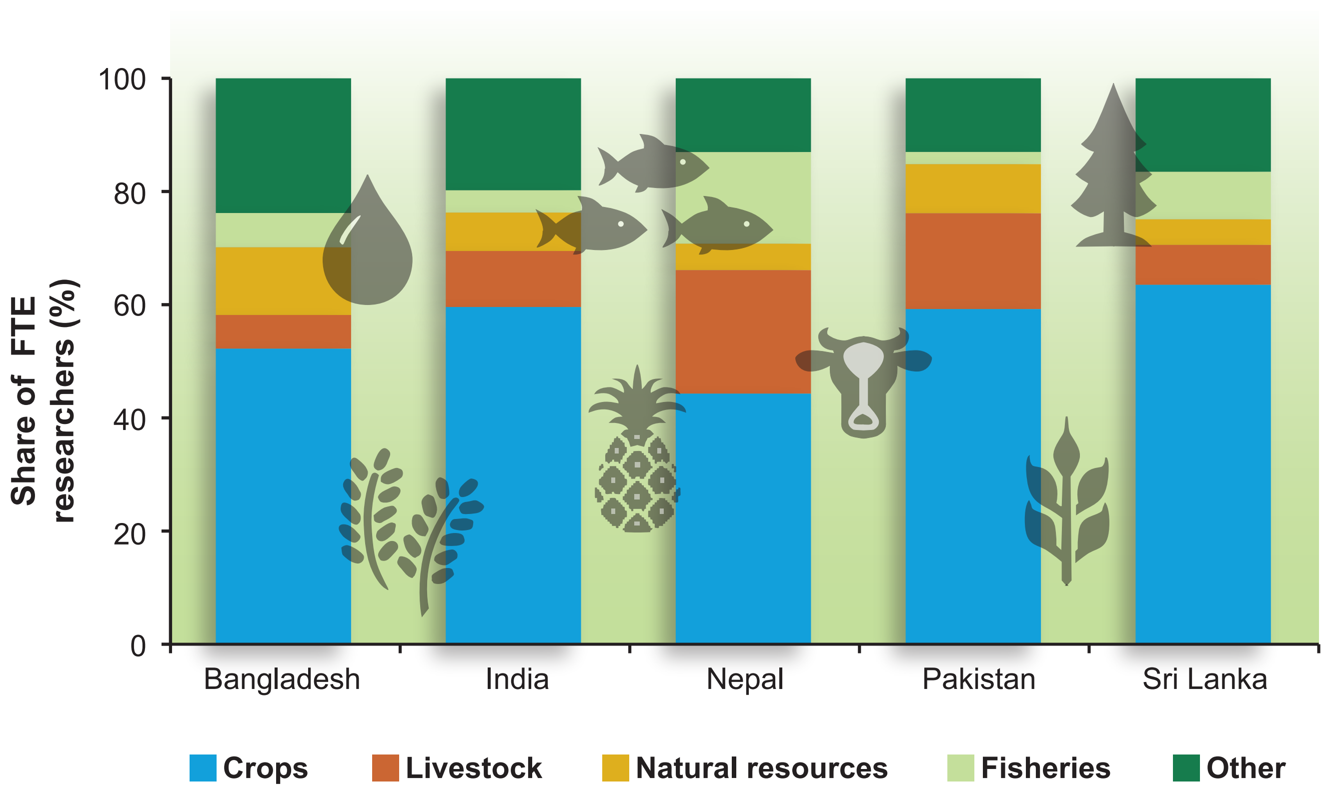
and take steps to make adjustments as necessary. Data for the five South Asian countries indicate that age imbalances are serious in Nepal (Figure 8). In 2009, 43 percent of NARC researchers in Nepal were over 51 years old, as were two-thirds of agricultural scientists at Tribhuvan University. The situation has improved somewhat in Nepal since the 2010 cessation of the public-sector recruitment freeze and subsequent recruitment of 70 young BSc-level scientists by NARC.

A closer look at the age distribution of scientists by degree qualification further demonstrates the severity and the urgency of the situation in Nepal, where more than two-thirds of PhD-qualified scientists are over 51 years old, and the official retirement age at government agencies is 60 years. Similarly, an average of around 40 percent of PhD-qualified scientists in Bangladesh, India, and Pakistan are 51 years or older. While Bangladesh, India, and Pakistan still have a significant number of PhD-qualified agricultural scientists in their 30s, Nepal employed only two in 2009. It goes without saying that the recruitment, training, and mentoring of young scientists will be a major priority in Nepal in the coming years.

Research Focus of Agricultural R&D Staff

The allocation of resources among various lines of research is a significant policy decision, so detailed information on the allocation of FTE researchers across commodity areas was collected. In 2009, 58 percent of the researchers in South Asia conducted research on crops (Figure 9). Livestock research accounted for 11 percent of FTE researchers, natural resources research for 8 percent, and fisheries research for 4 percent; the remaining 19 percent of agricultural R&D staff focused on forestry, postharvest issues, or other areas

Figure 9—Researcher focus by major commodity area, 2009



Source: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes available at www.asti.cgiar.org).

of research. These overall shares have not changed much since 2002/03 (Beintema and Stads 2008). Across the sample countries, Nepal stands out as having the lowest share of agricultural research staff focusing on crop research (44 percent) and the highest shares focusing on livestock and fisheries research, at 22 and 16 percent, respectively. In India, the SAUs allocate a much higher share of their research capacity to crops: 71 percent compared with 43 percent at ICAR agencies. ICAR invests more in areas such as fisheries, natural resource management, and agricultural engineering. Both ICAR institutes and the SAUs emphasize socioeconomic and statistical research that cuts across commodities and resources.

Rice is the most researched crop in South Asia, accounting for 14 percent of all crop research in 2009. Rice accounts for more than 12 percent of crop research in all the countries except Sri Lanka (Table 2). Research on fruit and wheat each accounted for 9 percent of all crop research. Wheat research is particularly prominent in Pakistan, where it is the most researched crop and accounts for close to a quarter of the country's total crop research. Other important crops in South Asia include vegetables (7 percent), cotton (5 percent), and maize (4 percent). More than half the subregion's researchers focus on crops that represent less than 3 percent of total crop research each, reflecting the wide variety in agroclimatic conditions across the subregion.

Table 2—Research focus of crop scientists by major crop item, 2009

Country	Major crop items
Bangladesh	Rice (19%), fruits (12%), vegetables (9%), potatoes (6%), sugarcane (6%), wheat (6%)
India	Rice (15%), fruits (9%), vegetables (6%), wheat (6%)
Nepal	Vegetables (20%), rice (19%), wheat (12%), maize (11%), fruits (9%)
Pakistan	Wheat (22%), rice (12%), cotton (10%), sugarcane (7%), fruits (7%), vegetables (6%), maize (5%)
Sri Lanka	Vegetables (15%), fruits (12%), tea (11%), coconut palm (10%), rice (5%)

Source: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes available at www.asti.cgiar.org).

Conclusion and Policy Implications

New quantitative evidence presented in this report demonstrates that total public agricultural R&D spending in South Asia more than doubled between 1996 and 2009, while the number of agricultural researchers decreased by 6 percent. These trends were largely driven by India, which has the highest investment levels and strongest human resource capacity in agricultural research in South Asia by far (both in terms of size and qualification levels), as well as the highest agricultural research spending intensity at 0.4 percent of AgGDP. Other aspects that set India apart from its neighbors are the comparatively important role of its private sector in agricultural R&D and the sweeping NAIP–stimulated agricultural R&D reform process, which is exploring new forms of consortia-based partnerships involving farmers and private enterprises to increase the relevance and efficiency of research. Overall, Indian agricultural research is relatively well-funded, although the budgets of some state agricultural universities have fallen in recent years.

Compared with India, agricultural R&D in the four other South Asian countries faces greater challenges (Table 3, page 22). Relative investment levels are lower in these countries than in India and have shown greater year-to-year fluctuations, in many instances due to the instability of donor funding. Agricultural research staff in these countries is also significantly less-qualified than in India, the combined result of prolonged recruitment freezes, losses of highly qualified senior staff, limited training opportunities, and an aging population of researchers. In addition, political instability in some countries has either delayed or complicated much-needed institutional and policy reforms. Some countries have been left with complex or outdated agricultural R&D structures that are unsuited to current needs. Various policy reforms have been or are in the process of being implemented to address some of these institutional inefficiencies, including the 18th Amendment to the Constitution in Pakistan (which devolved much of the oversight of the agriculture sector to the provinces); the Strategic Vision for Agricultural Research, 2011–30, in Nepal; NATP in Bangladesh, and NARP in Sri Lanka.

Despite rapid increases in recent years, South Asia's agricultural R&D spending is still very low compared with other developing regions around the world. Agricultural R&D intensity ratios in Pakistan (0.21) and Nepal (0.23) are among the lowest in the developing world, and even India (0.40) invests a considerably lower share of its agricultural output on agricultural R&D than other emerging economies such as China (0.50 in 2008) and Brazil (1.80 in 2006). These indicators are a clear sign that South Asia is underinvesting in agricultural research, which doesn't bode well for future generations. The subregion's population is predicted to continue to grow sharply until 2050, which—together with additional challenges stemming from climate change and environmental degradation—will necessitate increased food production. Being aware of these challenges, the subregion's national governments have set ambitious, but seemingly unrealistic, agricultural R&D investment targets. Investment levels not only need to increase, but also be better managed, timed, and targeted to ensure maximum impact on productivity growth and poverty reduction, particularly in less-favored areas. Increased diversification of funding sources will also be necessary, for example, through increases in the sale of goods and services and in participation by the private sector, which in turn requires that national governments focus on providing the necessary enabling policy environment.

The scientific competence of South Asia's agricultural R&D agencies is high, particularly in India, but as in many developing regions of the world, stronger linkages are needed to connect agricultural research agencies and their staff with the end users of their research to improve the relevance, effectiveness, and efficiency of research outputs. Further efforts to strengthen subregional linkages are also needed in order to better utilize limited resources and reduce wasteful duplication. In addition, good governance is key to promoting the effectiveness and efficiency of research, and ongoing policy and institutional reform will be needed to further strengthen agricultural R&D and innovation in South Asia.

Table 3—Public agricultural R&D in South Asia: An overview of key institutional, investment, and capacity strengths and challenges at the national level

Country	Characteristics
BANGLADESH	• Erratic yearly spending levels • Historic dependence on World Bank support for agricultural R&D • Recent capacity erosion, which has left the country with numerous unfilled research positions • The imminent retirement of senior researchers based on a low retirement age (59 years) • Very low participation of female scientists • A complex institutional structure that hinders effective coordination by BARC
INDIA	• Large R&D system with highly qualified staff • Strong agricultural education system • Rapidly increasing agricultural R&D spending levels • Enhanced private-sector role based on strengthening of IPR regime • Ongoing reforms stimulated by NAIP and involving research organizations, farmers, the private sector, and other stakeholders • Weakened research capacity at the SAUs, including fragmentation along disciplinary lines
NEPAL	• Lack of effective and efficient policy implementing bodies/instruments due to capacity and continuity struggles at ministerial levels • Rapidly aging pool of highly qualified scientists and numerous vacant positions at NARC • Very low participation of female agricultural scientists • Severe cuts in donor funding due to an unstable political situation requiring increased government funding of NARC • Comparatively strong participation by the nonprofit sector in the conduct of agricultural R&D • NARC reforms as part of Strategic Vision for Agricultural Research, 2011–30
PAKISTAN	• Decentralized agricultural R&D system with comparatively strong farmer linkages • Devolution (18th Amendment to Constitution) grants provincial institutes greater role in agricultural R&D, but unclear implications for ongoing funding • Restructuring of PARC to strengthen its relevance and effectiveness • Relatively well-staffed agricultural R&D system, but low shares of PhD-qualified scientists and low participation by female scientists • Low levels of public funding and high dependence on donor contributions to fund operations
SRI LANKA	• Decreased national government funding for agricultural R&D • Cess proceeds on the production/export of plantation crops no longer channeled to R&D • Relatively good science infrastructure • Public-sector recruitment restrictions precluded newly hired SLCARP scientists from attaining official researcher status • Very high participation by female scientists • Calls for an urgent increase in investment in agricultural R&D by NARP

Source: Compiled by authors based on ASTI Country Notes.

Notes

1. Data for Afghanistan, Bhutan, and the Maldives were not available.

2. These trends have been published in a series of ASTI Country Notes that are listed in the reference section and are available at <http://www.asti.cgiar.org/publications/ap>. Underlying datasets can be downloaded via ASTI's Data Tool at <http://www.asti.cgiar.org/data>.

3. In Pakistan, federal research institutes under PARC and NARC were counted as separate agencies, recognizing the degree of autonomy they exercise. However, each of the country's main provincial research institutes were counted as one agency, although they may have a number of scattered institutes, sections, departments, or directorates operating under their authority. Information from higher education agencies was collected in a more disaggregated manner, given that a university's focus may not be entirely on agriculture. For example, a Faculty of Agriculture and a Faculty of Veterinary Science placed under the same university are considered as two separate higher education units by ASTI.

4. In francophone West and Central Africa, for example, a significant proportion of researchers are over 50 years old; without the urgent recruitment and proper mentoring of young scientists, many R&D institutes in the region will face severe capacity losses in the coming years as these older scientists retire (Beintema and Stads 2011).

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978-0-89629-800-2