Agricultural Science & Technology Indicators

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INDIA

RECENT DEVELOPMENTS IN AGRICULTURAL RESEARCH

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Country Note • June 2012

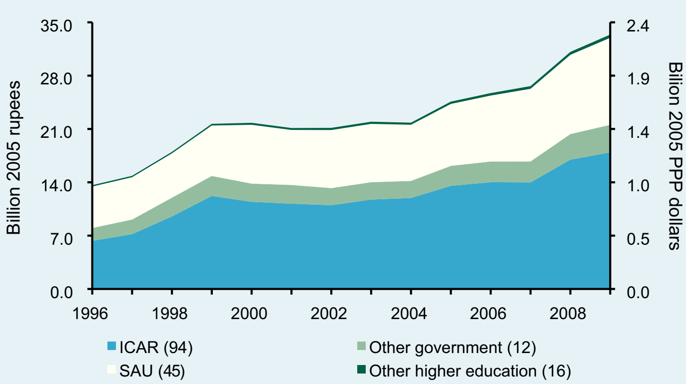
INTRODUCTION

Agricultural growth is critical for sustainable and inclusive economic growth in India, as the vast majority of the population depends on the agricultural sector for their livelihood. Close to 60 percent of India's labor force is employed in agriculture, according to the 2011 census. The majority of landholdings are small. Some 82 percent were classified as small scale in 2006; and farms less than two hectares occupied 40 percent of India's agricultural land (GoI 2011). Since the Green Revolution era, India has achieved impressive growth in agricultural production, boosting national food security and reducing poverty (Fan, Gulati, and Thorat 2008). But the agricultural sector still faces crucial challenges. Growth in agricultural production continues to lag behind the targeted 4 percent, and poverty and malnutrition remain widespread. Key development challenges for the coming decades are meeting the growing and diversifying food demand, especially for livestock and horticultural products, managing natural resources sustainably, and raising the productivity of rain fed agriculture.

Recent Key Trends

- India has one of the largest and well coordinated public agricultural research systems in the world. Its primary agencies are organized under the Indian Council of Agricultural Research (ICAR) and state agricultural universities (SAUs).
- Strong government commitment has resulted in a near doubling of public investment in agricultural research and development (R&D) since the mid-1990s. Funding is expected to increase further in the coming years.
- Public agricultural R&D is almost completely funded by the federal and states governments.
- The number of researchers declined by 17 percent during 2000–09, which was most pronounced at the SAUs.
- Private investment in agricultural R&D has increased fivefold since the mid-1990s.

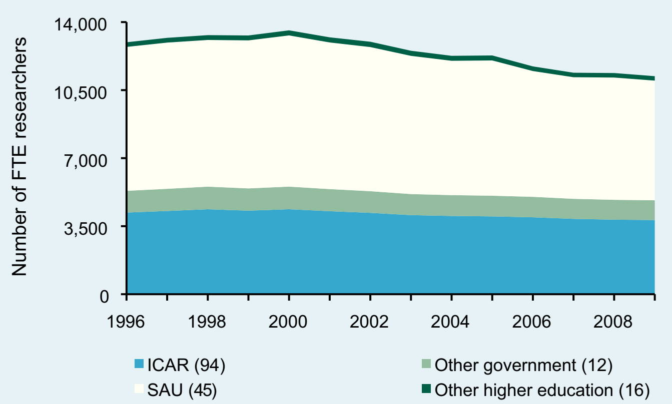
Figure 1—Public agricultural R&D spending adjusted for inflation, 1996–2009



Sources: Calculated by authors from GoI various years, ASTI–ICAR 2010–11, and Beintema et al. 2008.

Notes: Figures in parentheses indicate the number of agencies in each category. Years are fiscal years (April to March). Expenditure data for India's four commodity boards are included in "other government." Estimates for "other higher education" were derived according to the prevailing trends at ICAR and the SAUs. For more information on coverage and estimation procedures, see the India country page on ASTI's website at http://asti.cgiar.org/india. Expenditures for ICAR exclude three agencies because their involvement in agricultural research was negligible.

Figure 2—Public agricultural research staffing in full-time equivalents (FTEs), 1996–2009



Sources: Calculated by authors from GoI various years, ASTI–ICAR 2010–11, Beintema et al. 2008, and annual reports of various ICAR and SAU agencies.

Notes: Figures in parentheses indicate the number of agencies in each category. Years are fiscal years (April to March). For more information on coverage and estimation procedures, see the India country page on ASTI's website at http://asti.cgiar.org/india.

Table 1—Agricultural R&D spending and research staffing levels, 2009

Type of agency	Total spending: Indian rupees	Total spending: PPP dollars	Shares	Total staffing: Number	Shares
	(billion 2005 prices)		(%)	(FTEs)	(%)
ICAR (94)	17.9	1.2	53.7	3,816.7	34.0
Other government (12)	3.6	0.2	10.8	1,015.0	9.0
SAU (45)	11.4	0.8	34.2	6,158.0	54.9
Other higher education (16)	0.4	0.03	1.3	226.8	2.0
Subtotal public (167)	**33.4**	**2.3**	**100**	**11,216.5**	**100**
Private	**7.8**	**0.5**	—	**na**	—
Total	**41.2**	**2.8**			

Sources: Calculated by authors from GoI various years, ASTI–ICAR 2010–11, Pray and Nagarajan (2012) and annual reports of various ICAR and SAU agencies.

Notes: Figures in parentheses indicate the number of agencies in each category. For a complete list of ICAR agencies and the SAUs, please see http://asti.cgiar.org/india/profile. Since 2009, 10 more SAUs have been created. Expenditures for ICAR exclude three agencies because their involvement in agricultural research was negligible. Public-sector spending data are for fiscal year 2009-10; private sector spending data for fiscal year 2008-09. Private spending total differs from Pray and Nagarajan (2012) because these authors include agricultural machinery, food, and beverages. These industrial subsectors do not fall under this note's classification of agriculture. "na" indicates that data were not available.

Strong empirical evidence demonstrates that India's agricultural sector benefited considerably from past government investments in agricultural research and development (R&D) (Pal, Mathur, and Jha 2005). Evidence also indicates that investments in agricultural R&D have performed equally well or better than other public-sector investments in the agricultural sector (Fan, Gulati, and Thorat 2008). These facts have been essential in mobilizing increased government funding for agricultural R&D. But as Byerlee and Pal (2006) point out, the focus of agricultural research in India has widened and become more complex. The research system now grapples with the need to incorporate issues such as sustainable management of natural resources, food quality and safety, household food and nutritional security, and poverty reduction. Notwithstanding the rising trend in government funding for agricultural R&D, more resources will be needed to meet the needs of the growing population.

LONG-TERM INVESTMENT, CAPACITY, AND INSTITUTIONAL PATTERNS

India has one of the largest and well coordinated agricultural R&D systems in the world. It has been operational for more than a century, though its main expansion took place after independence in 1947. The tradition of strong government support to science and technology (S&T) has produced an excellent S&T infrastructure in India. It includes research laboratories, a wide network of institutions of higher learning, and a cadre of highly skilled human resources.

The Indian public agricultural research system has two tiers. The first tier is at the federal level and comprises mainly a network of close to 100 institutions coordinated by the Indian Council for Agricultural Research (ICAR). ICAR has been credited with ushering in the Green Revolution in India. The institute has also played a major role in promoting excellence in higher agricultural education (ICAR 2011). The second tier is at the regional level and consists of a system of state agricultural universities (SAUs) mandated to deliver state-specific research and education.

Public investment in agricultural R&D increased from 13.6 billion Indian rupees or 0.9 billion PPP dollars in 1996 to 33.4 billion rupees or 2.3 billion PPP dollars in 2009 (both in 2005 constant prices) (Figure 1; Table 1). Note that unless otherwise stated all dollar values in this report are based on purchasing power parity (PPP) exchange rates.[1] PPPs reflect the purchasing power of currencies better than standard exchange rates because they compare the prices of a broad range of local goods and services—as opposed to internationally traded ones.

In contrast to the steady positive trend in agricultural R&D investment, the number of full-time equivalent (FTE) researchers showed a slightly negative trend during 1996–2009 (Figure 2; Table 1). Though the number of FTE researchers rose during the late 1990s, it fell by 17 percent during 2000–09. In 2009, only 11,216 FTE researchers were active in India, compared with 13,575 in 2000.

ICAR was established in 1929, but it was renamed after India's independence and all federal agricultural research institutes were brought under its jurisdiction. ICAR is responsible for planning and coordinating agricultural research and education in the country, as well as managing the research of its 97 agencies. Together, these accounted for more than half of India's public agricultural R&D spending and about one-third of the country's agricultural researchers. Four of these agencies are deemed universities, 45 institutions, 17 national research centers, 25 project directorates, and 6 national bureaus (ICAR 2010). These entities vary considerably in size. With 318 FTE researchers in 2009, the Indian Agricultural Research Institute (IARI) is by far the largest institute in the ICAR system, followed by the Indian Veterinary Research Institute (IVRI), which employed 161 FTE researchers that same year. Only four other research institutes under ICAR employed more than 100 FTE researchers in 2009: the Indian Institute for Horticultural Research (IIHR, 137 FTEs), the National Dairy Research Institute (NDRI, 116 FTEs), the National Bureau of Plant and Genetic Resources (NBPGR, 105 FTEs), and the Central Arid Zone Research Institute (CAZRI, 103 FTEs). The research institutes and centers under ICAR focus primarily on research. The project directorates coordinate the various research areas conducted in the different agencies, including the SAUs. The national bureaus are active primarily in natural resource conservation.

ICAR institutes cover a broad range of categories: crops, horticulture, natural resources, agricultural engineering, animals, and fisheries. Four institutes have university status: IARI, NDRI, IVRI, and the Central Institute for Fisheries and Education (CIFE). Researchers in some of the other ICAR institutes also work as faculty at nearby SAUs.

Since the late 1990s, ICAR's expenditures have more than doubled—equivalent to an average growth of 7 percent per year. In 2009, the ICAR agencies combined invested 17.9 billion rupees or 1.2 billion PPP dollars. In addition to research and education functions, ICAR also supports a network of entities known as

Krishi Vigyan Kendras (KVKs). These are small teams that perform frontline extension activities. The KVKs are managed by the SAUs and voluntary organizations. In 2009, ICAR allocated about 10 percent of its budget to the KVKs and this share has increased substantially in more recent years. This growing capacity for field-level technology demonstration and transfer has been useful for tailoring technology recommendations and demonstrating them on farmers' fields. Since KVKs are not engaged in research, they have been excluded from this study.

In 2009, there were 45 SAUs. These employed 6,158 FTE researchers or 55 percent of India's public agricultural R&D staff. The SAUs are mandated to perform state-specific research and education. They vary widely in size. Those established in the 1960s employ more researchers, though some have been reorganized into smaller universities in recent years. With a faculty of 508 FTEs, the Chaudhary Charan Singh Haryana Agricultural University (HAU) is the largest SAU. Other large SAUs are the Punjab Agricultural University (PAU, 417 FTEs), the Acharya N. G. Ranga Agricultural University (ANGRAU, 388 FTEs), and Tamil Nadu Agricultural University (TNAU, 370 FTEs). Since 2009, 10 more SAUs have been created by upgrading auxiliary campuses into independent universities. This has brought their current number up to 55.

The aforementioned decline in the number of FTE agricultural researchers occurred throughout the system, but it was most severe within the SAUs. Their research staff dropped from a peak of 7,780 FTEs in 2000 to 6,158 FTEs in 2009. The faster decline at the SAUs can be attributed mainly to slow recruitment. Faced with difficult budgeting decisions, state governments have tended to postpone hiring of agricultural scientists. This has resulted in a large number of vacancies. Moreover, since the SAUs have both teaching and research roles, reduced personnel means that the available staff have less time for research. The extent of the drop was not equal across the SAUs. Hardest hit were the Acharya N. G. Ranga Agricultural University (ANGRAU) and the University of Agricultural Sciences Dharwad, where total FTE researchers fell by more than 40 percent during 2000–09. Only one SAU, the Narendra Deva University of Agriculture and Technology (NDUAT), experienced an increase in the total number of researchers during the same period. The decline in research capacity at the SAUs should be immediately addressed. One way to do this would be with grants specifically designed for the SAUs.

A number of other government and higher education agencies are involved in agricultural R&D in India, though their overall share is small. Other government agencies accounted for 9 percent of total public agricultural R&D capacity in 2009. Most important among these agencies are the eight institutes of the Indian Council of Forestry Research and Education (ICFRE). These institutes undertake forestry research related to climate change, biodiversity, desertification, and sustainable management (ICFRE 2011). Another four research agencies conduct research on plantation crops under the auspices of their respective boards. The other (non-SAU) higher education agencies accounted for about 2 percent of agricultural R&D capacity in 2009. These are nonagricultural universities that have agricultural faculties.

Private-sector participation in agricultural R&D is dominated by companies involved in breeding, biotechnology, animal health, plant protection, and farm machinery. Their role in Indian agricultural R&D began to expand as small national input companies gradually diversified into research. This trend was further stimulated by the participation of large national and multinational companies. Since the mid-1990s, agricultural R&D spending by the private sector has increased fivefold (Pray and Nagarjan 2012). In 2008–09, the private sector spent 7.8 billion rupees or 0.5 billion PPP dollars (both in 2005 constant prices), on agricultural R&D investment, accounting for 19 percent of India's total (public and private). This figure does not include research on agricultural machinery, food, and beverages. These industrial subsectors are excluded from the scope of agricultural research to allow international comparisons (they are also excluded from calculations of agricultural GDP). If included, total private agricultural R&D spending increased to almost 10 billion 2005 rupees.

An indicator often used to compare agricultural R&D spending across countries is the research intensity ratio, that is, total spending on agricultural R&D as a percentage of agricultural output (AgGDP). India's agricultural research intensity increased dramatically during 1996–2009, but most of the increase occurred in the late 1990s (Figure 3). In 1996, for every $100 of agricultural output, India invested $0.25 in agricultural R&D. By 2009, this had risen to $0.40. Yet the same period saw a decline in the number of FTE researchers in relation to the size of the farming population. In 1996, India had 57 FTE researchers per million farmers, compared with only 42 in 2009 (Figure 3).

ASTI Website Interaction

- More details on investments and capacity in agricultural research in India are available in the 2008 policy brief at www.asti.cgiar.org/pdf/PolicyBrief27.pdf.
- Underlying datasets can be downloaded using ASTI's data tool at asti.cgiar.org/data.
- A list of the 94 ICAR agencies, 12 other government agencies, 45 SAUs, and 16 other education agencies included in this brief is available at asti.cgiar.org/india/agencies.

asti.cgiar.org/india

POLICY ENVIRONMENT

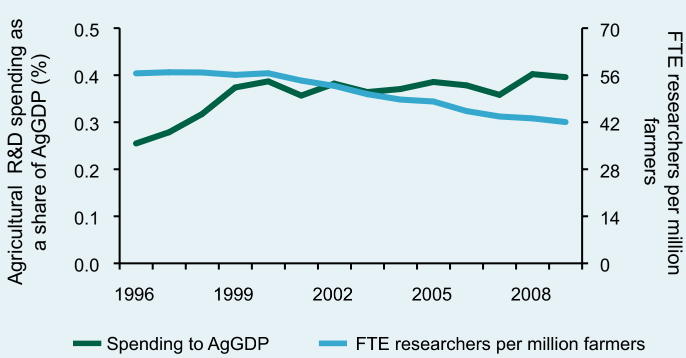
To address the emerging challenges facing Indian agriculture, a strategy must be devised that emphasizes key areas such as promoting innovations, strengthening institutional capacity, adapting to climate change, and fostering linkages and collaboration across institutions within and outside of the agricultural research system. To some extent the required research linkages are already in place. India has a number of coordinated programs that bring together public institutes with private-sector businesses and international organizations such as the centers of the Consultative Group on International Agricultural Research (CGIAR). ICAR manages 62 All India Coordinated Research Projects (AICRPs), most of which are based at and under the administrative control of the SAUs. AICRPs are a mechanism to build nationwide cooperative, interdisciplinary research networks. They link ICAR institutes with the SAUs and focus attention on nationally important commodities, resources, and species. AICRPs have been very successful in mobilizing India's scarce resources through inter-institutional and interdisciplinary collaboration and joint evaluation of new technologies. They have also strengthened the SAUs' research base.

The Indian government's twelfth five-year plan, covering 2012–17, targets an agricultural R&D intensity ratio of 1 percent of AgGDP. Though with the expanding research agenda, even this target may not be sufficient. India can achieve this goal if the state governments can increase their relative contributions and research institutes can increase internally generated funds. In particular, there is a need for greater resources for agricultural R&D in the northeastern states, which have lower funding intensity and inadequate research capacity. A competitive funding mechanism is currently under consideration that would help the research system address new challenges while fostering partnerships among the institutes. That mechanism, however, is still at the proposal stage.

A major focus of the Twelfth Plan is inter-institutional collaboration. This will be promoted by allocating more funding through ICAR to large commissioned projects in priority fields like genomics, water conservation, diagnostics and vaccines, farm mechanization, and postharvest management. Institutions both within and outside of ICAR and the SAU system will be involved in these collaborations.

The public sector will continue to dominate India's agricultural R&D system. It will therefore be called upon to take the lead in guiding the growing involvement of the private sector and developing synergies. Private-sector agricultural R&D presently focuses on high payoff fields, such as seed, farm machinery, animal and plant health, and agroprocessing. The private sector brings greater diversity and capacity to India's agricultural R&D system. To encourage private-sector involvement in agricultural technology development, India has strengthened its intellectual property rights (IPRs) regime in harmonization with international agreements. Furthermore, ICAR has put in place IPR guidelines geared to stimulate innovation by sharing research benefits with innovators. These guidelines will be useful in fostering partnerships with the private sector for the scaling up and commercialization of technologies developed in the public sector.

Figure 3—Intensity of public agricultural research spending and capacity, 1996–2009



Sources: ASTI–ICAR 2010–11; FAO 2011; and World Bank 2011.

ASTI Website Interaction

- Detailed definitions of PPPs, FTEs, and other methodologies employed by ASTI are available at asti.cgiar.org/methodology.
- The data in this brief are derived from surveys, secondary sources, or were estimated. More information on data coverage is available at asti.cgiar.org/india/datacoverage.
- More relevant sources on agricultural R&D are available at asti.cgiar.org/india.

asti.cgiar.org/india

An important institutional concern is the weakening research capacity of the SAUs. The SAUs were created on the US land grant pattern, with multiple faculties such as crops, horticulture, animal science, and fisheries. The practical interface of research, extension, and education is the traditional focus of these institutions. Though the SAUs have greatly expanded in number with funding support from state governments, their research capacity has weakened. The multidisciplinary nature is also diminishing, as some of the new SAUs were established to specialize in, for example, animal science, horticulture, or fisheries. Furthermore, though new SAUs have been created, there has been no parallel increase in numbers of scientists. This implies smaller research staffs at the individual universities and increased overhead costs due to the proportionally larger administrative burden of more institutes.

To strengthen organizational management, ICAR and the SAUs have implemented improved priority assessment and monitoring methods in recent years. These have resulted in better targeting of research, and they are being implemented at all levels of the system. Mechanisms for peer review of research programs have been put in place as well, and accreditation programs have been established to recognize excellence in education at the SAUs. These mechanisms are being complemented at the institute level by personnel management systems that use objective criteria for evaluating and rewarding scientist performance, career advancement, and lateral entry into the system.

ICAR and the SAUs currently have limited linkages with the government agencies under ICFRE and the plantation crop boards. This is because forestry and plantation crop research are conducted under the administrative control of their own central agency outside the Ministry of Agriculture. Their research, however, could benefit from links to the plant research done under ICAR and the SAUs. A stronger cross flow of technologies could be facilitated with establishment of a coordination mechanism encompassing forestry, plantation, and other basic research entities as well as the ICAR institutes and SAUs.

DEVELOPMENTS IN AGRICULTURAL R&D STAFFING

Despite the overall decline in research staff numbers, scientists at ICAR agencies became more highly qualified during 1996–2009. In 1996, 67 percent of ICAR scientists held a PhD degree. This increased to 80 percent in 2003 and further to 86 percent in 2009 (Figure 4). Advancement within ICAR and the SAUs requires a doctoral degree, though candidates with a master's degree qualify for entry-level positions.

ICAR and the SAUs also engage so-called "regular research staff." These staff assists scientists in their research and carry out maintenance of laboratories and experiment farms. Nearly 6,000 such staff is employed at ICAR agencies and some 3,000 at the SAUs. Their qualifications vary considerably, but most hold MSc degrees. The number of technical staff is high in the other government research agencies as well, and they hold similar qualification levels in their respective fields. ICAR and the SAUs employ a large number of support staff, but their number is currently on the decline as some support work is being outsourced.

In 2009, 37 percent of ICAR's agricultural researchers were between 41 and 50 years of age, 29 percent were between ages 51 and 60, and 7 percent were over the age of 60 (Figure 5). PhD-qualified researchers were significantly older than MSc-qualified researchers. Since the retirement age is 62, there is no concern about any immediate major loss in agricultural R&D capacity at ICAR agencies due to retirement.

RESEARCH FUNDING

Public agricultural R&D is funded by the federal government through ICAR and ICFRE and by the state governments through their respective SAUs. These contributions fall into two broad categories: plan and non-plan. Plan expenditures pay for new research programs, which are decided upon through a stepwise consultative process. The non-plan funds cover salaries and overhead costs. ICAR channels a significant portion of its resources to the SAUs as development grants and as funding for coordinated and on-farm research. Allocations to its various agencies are based on past trends and new research proposals. Additional major considerations are national R&D priorities, both short term and long term, and the growth potential of sectors and regions. Over time, for example, marginal production environments have received increased attention by both ICAR and the SAUs; their funding has therefore risen commensurate with their growing importance. Unfortunately, the SAUs still experience funding gaps. This is particularly true for those in the northeastern region, where rural poverty is especially widespread. These gaps have been filled by ICAR through the allocation of additional resources for establishment of new institutions and research programs for the region. Some agricultural R&D agencies in India generate funds internally through the commercialization of technologies and by offering contract research and services. However, these funds represent a negligible proportion of total incomes. Beintema et al. (2008) estimates that only 1 percent of the total funding of ICAR agencies came from internally generated income during 1995–2003. At an average of 6 percent, the corresponding share for the SAUs was much higher.

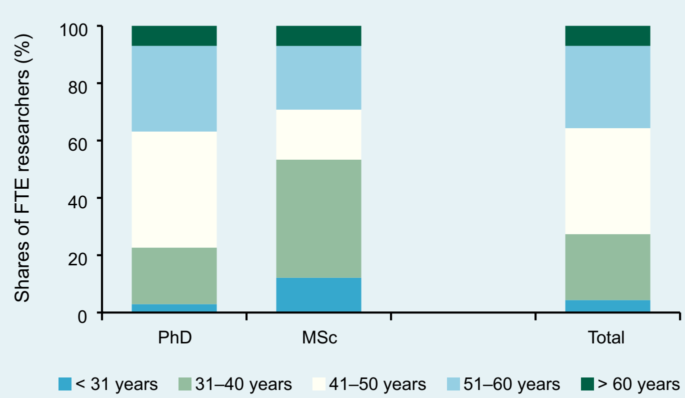
Donor support to Indian agricultural research has come mostly through projects funded by World Bank loans. Under the National Agricultural Research Project (NARP I and II) in

Figure 4—Degree qualifications of researchers at ICAR agencies, 1996, 2003, and 2009

Sources: ASTI–ICAR 2010–11; Beintema et al. 2008.

Notes: Degree data for ICAR scientists were provided by 62 ICAR agencies. Together these account for 70 percent of ICAR researchers. For more information on coverage and estimation procedures, see the India country page on the ASTI website at http://asti.cgiar.org/india.

Figure 5—Age distribution of researchers at ICAR agencies by degree, 2009



Source: ASTI–ICAR 2010–11.

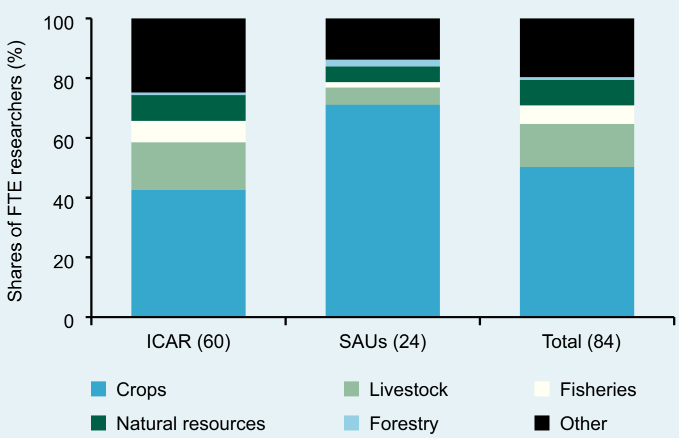
Notes: Age data for ICAR scientists were provided by 61 agencies. Combined, these account for 69 percent of ICAR's total research staff. For more information on coverage and estimation procedures, see the India country page on the ASTI website at http://asti.cgiar.org/india.

the 1970s, 127 regional research stations were established at the SAUs to carry out adaptive research and provide technical support to frontline extension activities. The National Agricultural Technology Project (NATP), operational from 1998 to 2005, had three main objectives: improving the efficiency of ICAR's management and organization; raising the effectiveness of research programs, especially those with an eco-regional approach; and creating a more effective and financially sustainable technology dissemination system, including wider participation of farmers (World Bank 2006).

NATP was followed by the National Agricultural Innovation Project (NAIP), initiated in 2006 and funded, in part, by a World Bank loan of some US$200 million (in current prices). NAIP's overall objective is to use agricultural innovation to transform the Indian agricultural sector, rendering it more market oriented and able to contribute to poverty relief and economic growth. The project seeks consortium-style collaboration as well, involving research organizations, farmers, the private sector, and other stakeholders. NAIP envisions a strengthened ICAR as the main catalyzing agent within the agricultural research system. In such a role, ICAR would manage change, provide funding for research in production-to-consumption systems and sustainable rural livelihood security, and support basic and strategic research in frontier agricultural science (World Bank 2006).

A small portion of NAIP funds (and earlier, NATP funds) have been used for competitive grant schemes. Competitive research grants in India are also provided by the Department of Science and Technology (DST) and the Department of Biotechnology (DBT). These funds are all similar in that they cover operating costs for short-term projects, but do not provide funds for salaries or infrastructure (Pal and Byerlee 2006; Beintema et al. 2008).

Figure 6—Research focus by major commodity area, 2009



Source : ASTI–ICAR 2010–11.

Notes: Figures in parentheses indicate the number of agencies in each category. Research focus data were provided by 60 ICAR agencies and 24 SAUs. Combined, these account for about 70 percent of the researchers at these agencies. For more information on coverage and estimation procedures, see the India country page on ASTI's website at http://asti.cgiar.org/india.

ALLOCATION OF RESOURCES ACROSS COMMODITIES

Broad resource allocation decisions are manifest in the organization of institutes and the recruitment of scientific staff. ASTI data on resource allocation across commodities is derived in part from detailed information on the number of researchers working in specific commodity areas (in FTEs). In 2009, 50 percent of the FTE researchers employed by ICAR and the SAUs performed crop research. This is not surprising, because food security is still a key research objective. Therefore, a great deal of attention is given to crop research in all agencies. Other important areas are livestock (14 percent), natural resources (8 percent), and fisheries (6 percent) (Figure 6). The importance rankings of the various commodity areas are similar in the different agencies, but the SAUs allocate a much higher share of research capacity to crops: 71 percent compared to 43 percent at ICAR agencies. ICAR invests more in areas such as fisheries, natural resource management, and agricultural engineering. The remaining researchers focused on other areas. For example, both ICAR institutes and the SAUs emphasize socioeconomic and statistical research that cuts across commodities and resources. These allocations of FTE researchers are broadly congruent with economic importance (Pal and Byerlee 2006).

Table 2—Public agricultural R&D spending and intensity ratio, 2000 and 2008

	Public agricultural R&D spending			
Countries/regions	2000	2008	2000	2008
	(billion 2005 PPP prices)		($ per $100 of AgGDP)	
India	1.5	2.3	0.36	0.40
Brazil	1.2	1.3	1.86	1.80
China	1.7	3.4	0.38	0.50
Australia	0.8	0.6	4.57	3.56
Japan	2.6	2.7	4.06	4.75
South Korea	0.6	0.7	1.60	2.30

Sources: For India see Figure 1. Data for Australia, Brazil, Japan, and South Korea were compiled by authors using OECD 2012 and Beintema, Avila, and Fachini 2010. Data for China is from Chen, Flaherty, and Zhang 2012.
Note: Public agricultural R&D spending data for Brazil are for 2006, the last year for which data were available.

INDIAN R&D IN A GLOBAL CONTEXT

India, China, and Brazil have become major forces in the global agricultural economy. It is therefore useful to compare Indian agricultural R&D investment trends with those in these two other emerging economies. India's recent spending growth in public agricultural R&D was impressive at 25 percent during 2000–07, but did not keep pace with China, where spending almost doubled during the same period. Brazil has one of the most well-established and well-funded research systems in the developing world, although spending levels there have fluctuated over the past two decades. Rapid growth, particularly in China, has meant that investments by the three countries combined accounted for at least half of the developing world's total public investment in agricultural R&D in 2000 (Beintema and Stads 2010).

India invested $0.40 for every $100 of AgGDP in 2008 (Table 2). This is less than the comparative figure for China, which invested $0.50 for every $100 of AgGDP in 2008; it is also less than the average of $0.56 for developing countries in 2000 (Beintema and Stads 2010). In contrast, Brazil and Asia's high-income countries invested much larger shares of their AgGDP in R&D, ranging from $1.80 for Brazil to $4.75 for Japan.

CONCLUSION

India has substantially increased its public funding of agricultural research since the late 1990s. This trend will likely continue in years to come. The Indian government's strong commitment to agricultural R&D has been rewarded with high economic and social returns to research investments. Nonetheless, India's research intensity ratio, measured as public agricultural R&D spending as a share of agricultural output, continues to be relatively low. In its upcoming twelfth five-year plan, the Indian government seeks to address this deficiency by committing 1 percent of AgGDP to agricultural R&D.

ICAR and the SAU system are making a concerted effort to better target research and to improve coordination of programs across the various institutions. Deliberate efforts are also being made to foster partnership with the farming community and with other stakeholders, so as to accelerate the flow of technology.

The quality of India's research staff has improved, as evidenced in the growing share of PhD-qualified researchers. But the number of researchers has fallen by 8 percent since the turn of the millennium. This drop is primarily driven by declining research capacity at the SAUs due to budget constraints. Without an effective policy response, the state research capacity will decline further, leading to less time spent on research by SAU faculty. A final concern is the fragmentation of SAUs along disciplinary lines. A trend toward greater specialization could hinder integrated technology development and demonstration on farmers' fields.

NOTE

[1] Financial data in current local currencies and constant 2005 US dollars are accessible through ASTI's data tool, available at www.asti.cgiar.org/data.

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The authors thank all of the agencies that participated in the ASTI survey in India; without their commitment this country note would not have been possible. The authors would also like to thank Dr. S. Ayyappan, the Secretary of the Department of Agricultural Research and Education (DARE), and the Director General of ICAR for allowing this collaboration, and to Dr. A. K. Bawa, and Subhash Chandra and Bhawana Joshi who provided support in data collection. Finally, the authors would like to thank Gert-Jan Stads who provided comments on an early draft of this note. ASTI gratefully acknowledges the generous support from the Bill & Melinda Gates Foundation.