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ASTI BACKGROUND NOTE
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Public Agricultural R&D Investments and Capacities in Developing Countries

RECENT EVIDENCE FOR 2000 AND BEYOND

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UPDATES ON 2000 GLOBAL INVESTMENT TRENDS IN PUBLIC AGRICULTURAL R&D

Compiling up-to-date, accurate information on global trends in public agricultural R&D investments is extremely challenging because for many countries no such information exists, and for others the available information is outdated, irregular, or incomplete. The Agricultural Science and Technology Indicators (ASTI) initiative strives to redress this problem, but—as a public good—ASTI focuses on developing countries (herein defined as low- and middle-income countries). In addition, based on financial and time constraints, ASTI collects data on a regional basis and over considerable intervals of time.[1]

In efforts to achieve global coverage, ASTI links its science and technology (S&T) indicator datasets to those of the Organisation for Economic Co-operation and Development (OECD); Eurostat; and country-specific datasets, such as ERS-USDA 2010 (for the United States), Chen and Zhang 2010 (for China), and Mullen 2007 (for Australia). Given the irregular nature of data collection and the time lags involved in accumulating, compiling, analyzing, and refining it (meaning filling gaps, addressing anomalies, and interpolating omissions), ASTI's most recent datasets for Sub-Saharan Africa are dated 2000/01, for Asia are dated 2002/03, and for Latin America are dated 2006; country coverage for West Asia/North Africa, on the other hand, is highly limited. Given these realities, the most recent year for which we have a complete global overview of public agricultural R&D investments is 2000.

That said, in 2008 ASTI revised its global analysis of public agricultural R&D investments in response to a major World Bank revision of its recommended method of calculating cross-country comparisons of the prices of goods and services (see Beintema and Stads 2008a).[2] In addition, ASTI took this opportunity to update its country classifications to reflect the

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1. Given that ASTI is funded through project proposals, it has not been able to collect data more regularly. This situation has been helped somewhat by the generous support of the Bill and Melinda Gates Foundation for the period 2008–11, but staffing and funding constraints still limit the breadth of ASTI's coverage and our ability to perform regular updates.

2. The method in question is purchasing power parity indexes, or PPPs, which are synthetic exchange rates that more effectively reflect the purchasing power of national currencies than do standard exchange rates because they compare the prices of a broader range of local—as opposed to internationally traded—goods and services. For a more detailed explanation of why PPPs are the preferred method of standardizing cross-country agricultural R&D investments, see Beintema and Stads 2008a.

growing diversity of developing-country economies and to incorporate newly released estimates of growing diversity of developing-country economies and to incorporate newly released estimates of agricultural R&D investments for Latin America and the Caribbean and a number of other developing and developed countries.

This current note presents a further revision to include expanded data coverage for Brazil and China—both of which have a major impact on regional and global aggregates given their size—and to include newly available Eurostat data for previously omitted Eastern European countries and former Soviet States, most of which are classified as low and middle income, but a few of which (such as Croatia, Czech Republic, Estonia, Hungary, Slovakia, and Slovenia) have high-income status.

For a 171-country revised sample in 2000, the combined effect of these updates results in a total global estimate of public agricultural R&D investments of 25.2 billion 2005 PPP dollars. Of this amount, $13.5 billion was spent in the 40 high-income countries (53 percent), $9.1 billion was spent in the 82 middle-income countries (36 percent), and $2.6 billion was spent in the 49 low-income countries (11 percent) included in our sample (Table 1).

TABLE 1. Public agricultural R&D spending by region and major country, 2000

Country category	Spending (Million 2005 PPP dollars)	Shares (%)
A. Country grouping by income class		
Low-income countries (49)	2,646	11
Middle-income countries (82)	9,056	36
High-income countries (40)	13,456	53
Total (171)	*25,158*	*100*
B. Low- and middle-income countries by region		
Sub-Saharan Africa (45)	1,239	5
China	2,250	9
India	1,301	5
Asia–Pacific (26)	5,120	20
Brazil	1,247	5
Latin America and the Caribbean (25)	2,755	11
West Asia and North Africa (12)	1,412	6
Eastern Europe and Former Soviet States (23)	1,177	5
Subtotal (131)	*11,702*	*47*

Sources: Updated from Beintema and Stads (2008a) using new datasets for Brazil from ASTI (various years), Eurostat (various years), and Chen and Zhang (2010).

THE IMPORTANCE OF AGRICULTURAL SCIENCE AND TECHNOLOGY INDICATORS

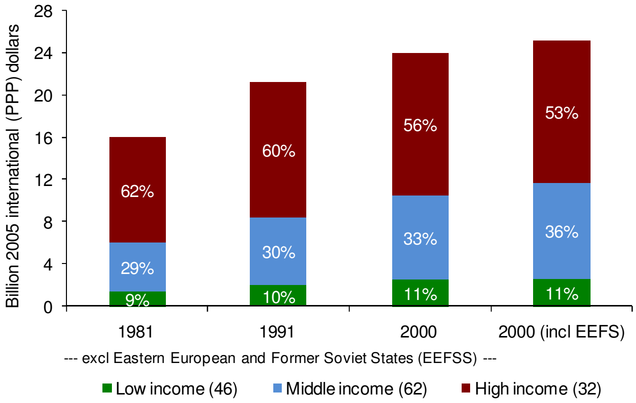
Policymakers are increasingly recognizing that higher levels of investment in agricultural research are a key factor in increasing agricultural production to the levels required to feed the world's growing population. Furthermore, additional investments in agricultural research are required to address emerging challenges, such as increasing weather variability, adaptation to climate change, water scarcity, and increased price volatility in global markets. Despite this growing attention to the agricultural sector and the role of agricultural research, many low- and middle-income countries continue to struggle with serious and deepening capacity and funding constraints in their agricultural research and higher education systems.

Quantitative information is fundamental to understanding the contribution of agricultural science and technology (S&T) to agricultural growth. Indicators derived from such information allow the performance, inputs, and outcomes of agricultural S&T systems to be measured, monitored, and benchmarked. These indicators assist S&T stakeholders in formulating policy, setting priorities, and undertaking strategic planning, monitoring, and evaluation. They also provide information to governments, policy research institutes, universities, and private-sector organizations involved in public debate on the state of agricultural S&T at national, regional, and international levels.

Overall, high-income countries increased their public agricultural R&D expenditures in absolute terms, and total global spending also continued to grow; however, the high-income country share of global spending decreased from 62 to 56 percent between 1981 and 2000 (Figure 1). In contrast, the low- and middle-income country spending shares actually increased from 9 to 11 percent and 29 to 33 percent, respectively, over the same timeframe, and these shares would be even higher if data for 23 low- and middle-income countries and states in Eastern European and the former Soviet Union—for which no time-series data were available prior to 1998—were included.

Growth in inflation-adjusted spending slowed after a period of high growth for most regions in the 1970s (Figure 2). The revisions also indicate that overall spending in developing countries increased by 2.1 percent per year on average during the 1990s, which was lower than the 3.0 percent growth rate recorded a decade earlier. Annual spending

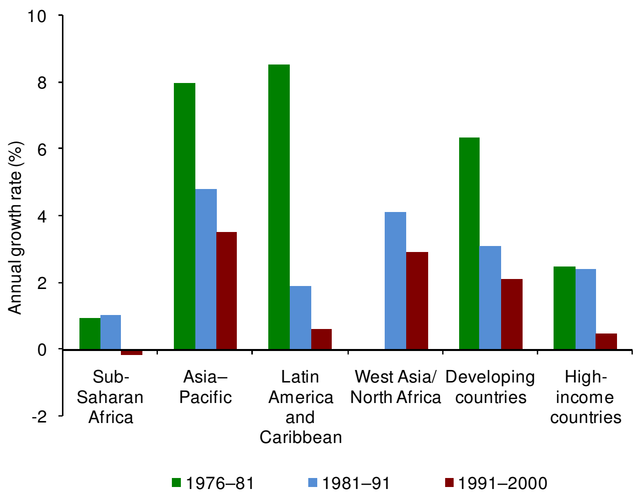
FIGURE 1. Public agricultural R&D trends, 1981–2000



Sources: See Table 1.

growth in the Asia–Pacific and in West Asia/North Africa remained comparatively high during the 1990s, at 3 percent a year. The Latin American and Caribbean region and high-income countries as a whole experienced moderate spending growth over this time (0.6 and 0.5 percent, respectively), whereas total public agricultural R&D spending in Sub- Saharan Africa decreased at an annual average rate of 0.2 percent during the 1990s. Furthermore, in about half of the region's 24 countries for which time-series data were available, the public sector spent less on agricultural R&D in 2000 than it had 10 years earlier.

FIGURE 2. Growth rates in public agricultural R&D expenditures, 1976–2000

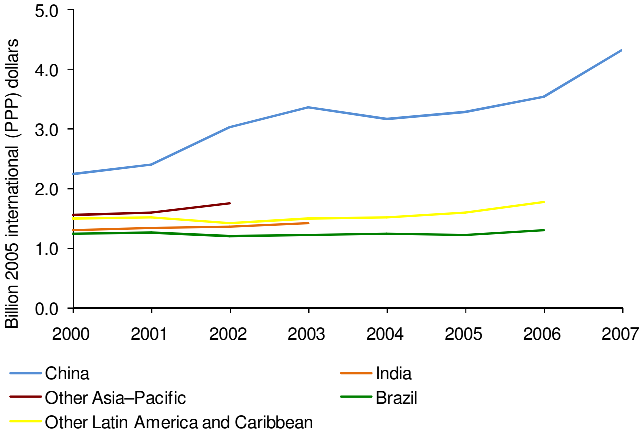


Sources: See Table 1. Growth rates for 1976–81 are from Pardey and Beintema (2001).
Note: Growth rates exclude Eastern Europe and Former Soviet States.

POST-2000 TRENDS IN AGRICULTURAL R&D INVESTMENT IN DEVELOPING COUNTRIES

Although post-2000 data on global public investment trends remain unavailable, more recent data collected by ASTI are available for a number of regions, the main results of which are presented below (Figure 3).

FIGURE 3. Evidence on agricultural R&D investment trends since 2000



Source: Data for Brazil, India, other Asia–Pacific, and other Latin America and Caribbean are from ASTI datasets (various years); data for China are from Chen and Zhang (2010).
Note: For details of country coverage, see ASTI's regional reports (Beintema and Stads 2006, 2008b; Stads and Beintema 2009).

The Asia–Pacific

The Asia–Pacific region is highly diverse in its geography, culture, politics, and history, and this diversity extends to its economic and agricultural development, and consequently to its agricultural R&D systems. Several countries have well-managed and funded systems producing world-class research, while others—some of which are highly dependent on agriculture—have experienced significant reductions in their R&D spending and research intensity levels since the early 1990s. In 2002, the Asia–Pacific region as a whole (excluding its high-income countries, such as Japan and South Korea) spent \$6.2 billion on agricultural R&D in 2005 PPP prices, but China and India accounted for nearly 70 percent of this total (\$3.0 and \$1.4 billion, respectively, based on Beintema and Stads 2008a and adjusted data for China from Chen and Zhang 2010).

Regional investments in agricultural R&D grew considerably after the early 1990s, largely because both China and India intensified their agricultural research spending. Other smaller countries, such as Malaysia and Vietnam, also realized impressive agricultural R&D spending growth from 1990 to 2002, whereas spending in Pakistan, Indonesia, and Laos was sluggish and at times negative in response to the Asian financial crisis, the completion of large donor-financed projects, or high rates of inflation (Beintema and Stads 2008b). China's public agricultural R&D spending continued to increase after 2002 in inflation adjusted terms: in 2007 it totaled $4.3 billion, which is close to twice its 2000 total of $2.3 billion. This translates to a growth rate of about 10 percent per year during 2000–07 compared with a rate of only 4 percent during the 1990s (Chen and Zhang 2010).

Latin America and the Caribbean

In 2006, as a whole, Latin America and the Caribbean spent close to $3.1 billion on public agricultural R&D (in 2005 PPP prices), although the bulk of these investments were made in Argentina, Brazil, and Mexico. Many of the region's countries realized impressive growth in agricultural R&D spending during 1996–2006, whereas spending in other countries declined, highlighting a worrying gap in spending trends between the region's low- and middle-income countries (Stads and Beintema 2009).

Brazil is the region's dominant country in terms of agricultural R&D spending, accounting for 42 percent of total spending in 2006 (based on adjusted data for Brazil from Beintema, Avila, and Fachini 2010). Brazil's public agricultural R&D spending declined during the second half of the 1990s but remained fairly constant thereafter, although yearly levels remained erratic. Total spending levels, however, are expected to increase substantially during the next few years due to increasing budget allocations earmarked for Brazil's main public agricultural research agency, Embrapa (Beintema, Avila, and Fachini 2010).

Sub-Saharan Africa

As previously mentioned, ASTI's most recent regional results for Sub-Saharan Africa are for 2000/01. ASTI is, however, in the final throes of collecting and analyzing data for over 30 Sub-Saharan African countries, and will release updated investment and capacity trends to 2008 in July 2010. Because the data synthesis in a number of key countries has yet to be completed, preliminary results for the region as a whole are not available, but some initial country-level trends for 2000–08 indicate declining spending growth in some countries, stagnating growth in others, and a substantial increase in spending in others, as follows:

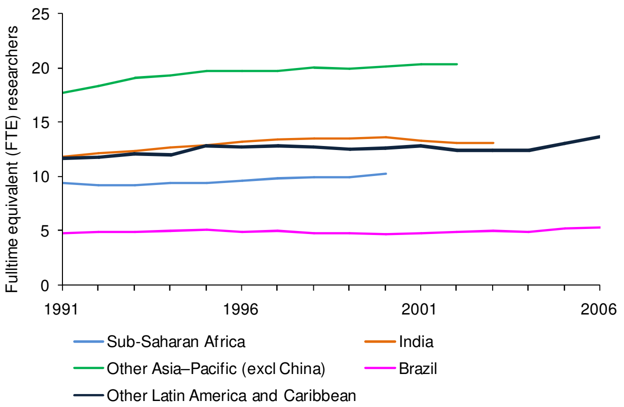
- Both Ghana and Nigeria have seen a substantial increase in total government agricultural R&D spending—specifically at the nine agencies under Ghana's Council for Scientific and Industrial Research (CSIR) and the 15 research institutes coordinated by the Agricultural Research Council of Nigeria (ARCN), respectively. This contrasts stagnating public agricultural spending growth in both countries during the 1990s.
- Continuing a trend observed during the 1990s, agricultural research and development (R&D) expenditures in Kenya varied year to year because spending at the country's main agency, the Kenya Agricultural Research Institute (KARI), was affected by fluctuating donor funding.
- Developments in agricultural R&D spending in many francophone West African countries were not as favorable as those in Nigeria, Ghana, and Sierra Leone, three of the region's anglophone countries. During 1998–2008, total agricultural R&D investments in Guinea fell by 75 percent due to reduced support from the World Bank and France. Though not as severe as in Guinea, many other of the region's countries experienced considerable reductions in their overall agricultural R&D spending levels in the decade to 2008. Levels in Burkina Faso, the Republic of Congo, Gabon, Mali, Mauritania, and Senegal fell significantly, whereas those in Benin, Côte d'Ivoire, and Togo remained more or less stable. Agricultural R&D in many of West Africa's francophone countries remains highly dependent on foreign donors and development

banks, and reduction in this funding source is a major contributor to declining agricultural R&D investments in many countries in this subregion.

RECENT AGRICULTURAL R&D CAPACITY TRENDS IN DEVELOPING COUNTRIES

In addition to the investment trends, which have been more frequently cited, ASTI also collects information on the number of full-time equivalent (FTE) researchers employed in agriculture in developing countries (Figure 4). Capacity trends in many countries have been less erratic than investment trends. Overall most low- and middle-income countries in Sub-Saharan Africa, Latin America, and the Asia–Pacific have made considerable progress in building their research staff capacity, both in terms of total researcher numbers and qualification levels (in terms of postgraduate levels). The participation of female scientists has also increased in a large number of countries.

FIGURE 4. Public agricultural research capacity trends, 1991–2006



Source: ASTI datasets (various years).
Note: For details of country coverage, see ASTI regional reports (Beintema and Stads 2006, 2008b; Stads and Beintema 2009).

Asia–Pacific

Employing more than 80,000 FTE scientists and engineers in agriculture in 2008 (Chen and Zhang 2010), China has the world's largest agricultural R&D system in terms of research staff numbers. But the region also encompasses small Pacific islands with less than 100 FTE researchers each. The average qualifications of staff also varied widely across countries. Nonetheless, all 11 Asia–Pacific countries included in ASTI's 2002 survey (which excluded China) reported improvements in the qualification levels of agricultural scientists in the previous decade, despite the staffing challenges facing certain countries (Beintema and Stads 2008b).

In 2002–03, close to three-quarters of all FTE researchers in the 11-country sample had postgraduate-level training—35 percent held PhD degrees and 39 percent held MSc degrees. While there were large variations across countries, generally speaking the shares of researchers with MSc or PhD degrees was higher in the five South Asian countries than it was in the six Southeast Asian countries. Numbers of staff qualified to the postgraduate level were particularly low in Laos and Vietnam, countries with a history of political and economic isolation, but the Philippines and Papua New Guinea also had relatively few well-qualified researchers.

Latin America and the Caribbean

In 2006, Latin America and the Caribbean as a whole employed roughly 19,000 FTE researchers in agriculture, although just three countries—Argentina, Brazil, and Mexico—accounted for 70 percent of them. Chile, Colombia, Peru, and Venezuela each accounted for between 4 and 6 percent, whereas the combined capacity of the remaining 20 countries constituted 14 percent of the regional total. Argentina and Mexico both experienced significant capacity growth during 1981–2006. In El Salvador, Guatemala, and Honduras, capacity growth was significantly negative, largely due to reduced government spending or the completion of donor-funded projects. The other countries experienced moderate capacity growth, but to a far lesser degree than either Argentina or Mexico (Stads and Beintema 2009).

In 2006, of the total number of agricultural research staff in the 15-country sample, 33 percent were trained to the PhD degree level, 32 percent were trained to the MSc degree level, and 34 percent were trained to the BSc degree level. From a national perspective, Brazil's agricultural researchers were the most qualified, followed by Chile and then Uruguay. Overall, agricultural researchers in Central America are less well-qualified than their counterparts in other parts of Latin America (Stads and Beintema 2009).

Sub-Saharan Africa

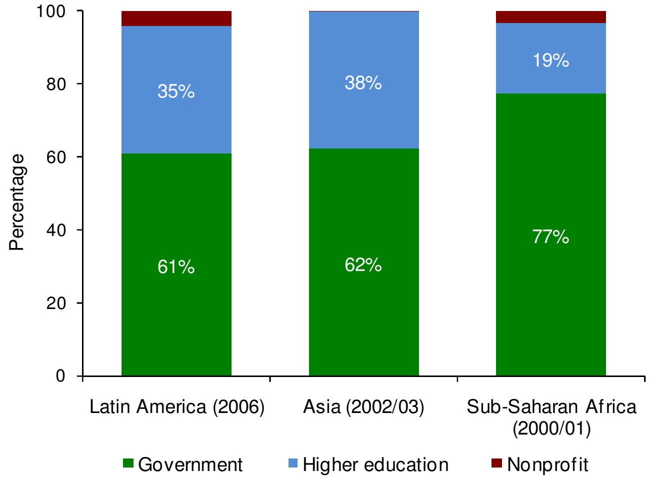
Sub-Saharan Africa made considerable progress in building research staff capacity in the 1970s and 1980s. Initial results from the previously mentioned current 2008 synthesis indicate that a large number of African countries are struggling to maintain viable agricultural R&D capacities. A key problem in countries like the Republic of Congo, Madagascar, and Senegal is their aging—and hence imminently retiring—pool of qualified researchers. Retiring research staff members are often not replaced due to bans on public-sector recruitment in many countries. Some institutes fill their vacant positions by hiring long-term consultants that do not appear on the government payroll, but resources to pay for these consultants are also scarce. In the Republic of Congo, for example, a recruitment ban has been in place in the public sector since 1986, and a substantial share of the county's researchers (60 percent at the main government research agency) are scheduled for retirement within the next six years. Senegal is a similar example, reporting significant attrition in PhD-qualified research staff, again accompanied by an aging pool of well-qualified researchers.

THE ROLE OF NATIONAL GOVERNMENTS

Performing Public Agricultural R&D

The government sector is still the main performer of public agricultural R&D, both in terms of execution and funding (Echeverría and Beintema 2009). The government sector accounted for 61, 62, and 77 percent of total FTE researchers in Latin America (based on 2006 data), Asia (excluding China, based on 2002/03 data), and Sub-Saharan Africa (based on 2000/01 data), respectively (Figure 5). Despite the prominent role of the government sector, the higher education sector has gained ground in a number of countries, although the individual capacity at many higher education agencies remains very small. In 2002, for example, 148 higher education units were involved in agricultural research in the Philippines, 112 of which employed 10 FTE researchers or fewer. India employed more researchers in the higher education sector than in the government sector due to a land-grant system that closely links education and research. In a number of other countries, the research capacity in higher education approaches that found in the government sector.

FIGURE 5. Institutional orientation of agricultural research since 2000, various years



Source: ASTI datasets.
Note: For details of country coverage, see ASTI's regional reports (Beintema and Stads 2006, 2008b; Stads and Beintema 2009).

Funding Public Agricultural R&D

Although several relatively new funding mechanisms may contribute to agricultural R&D, the government sector remains the largest contributor to public agricultural research (Echeverría and Beintema 2009). On average, government allocations accounted for 81 percent of funding for a sample of over 400 government agencies in 53 developing countries (Figure 6). Only 7 percent of this funding was derived through donor contributions, in the form of both loans and grants, mostly in highly donor-dependent countries in Sub-Saharan Africa and a few countries, such as Laos and Nepal in Asia and Nicaragua in Latin America.[3] Internally generated funding, including contractual

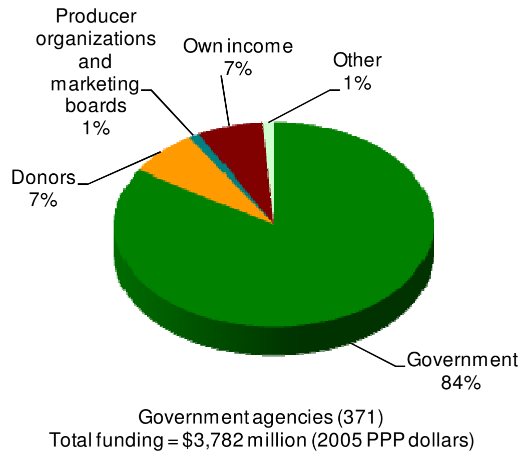
3. Donor contributions are not always directly dispersed to research agencies; in some cases they are channeled through the government, so, in reality, the donor share of funding is probably slightly higher.

arrangements with private and public enterprises, accounted for 7 percent of total funding on average. This does not include the growing role of private foundations in funding agricultural research in recent years, the most important of which is the Bill and Melinda Gates Foundation, which in 2009 approved more than US$320 million in agricultural development grants focusing on Sub-Saharan Africa and South Asia.

Although the bulk of public agricultural research is still predominantly funded by the government, new sources of funding are emerging in some countries. In particular, competitive funding mechanisms, internally generated revenues, and production or export levies have gained prominence. Competitive funding schemes have become important in public agricultural R&D in a number of Latin American and Asian countries (such as Chile, Mexico, India, Indonesia, Malaysia, and Sri Lanka), but they are limited in Sub-Saharan Africa.

Generating internal revenues has become important in countries like China, Indonesia, Chile, and Côte d'Ivoire, but these funds are generally channeled back to the national treasuries, removing agency incentives to focus on selling products and services. Although producer levies account for only a small share of the total funding sources in public agricultural R&D, they are important in a few countries. The most advanced country in this regard is Colombia, which has 13 producer organizations either generating funding through production income or export levies to conduct their own research or finance to do so on their behalf. A number of other countries in Latin America, as well as some in Asia and Africa have introduced levy systems, mostly on export crops (Echerverría and Beintema 2009).[4]

FIGURE 6. Funding sources for government research agencies since 2000, various years



Source: ASTI datasets as presented in Echeverría and Beintema (2009).
Note: Data coverage is 2000/01 for Sub-Saharan Africa, 2002/03 for the Asia–Pacific, 2002/04 for West Asia/North Africa, and 2006 for Latin America. The total number of countries included is 53. Data exclude a number of major countries, such as China in the Asia–Pacific, and South Africa and Nigeria in Sub-Saharan Africa.

CONCLUSION

Revised data analyses for the Asia–Pacific and Latin America and the Caribbean regions, along with initial analyses for Sub-Saharan Africa that have yet to be finalized, indicate that—more than ever—the knowledge divide among rich and poor countries (the so-called scientific "haves" and "have-nots") is growing. A large number of low- income countries continue to experience reduced donor support and lack of prioritization of agricultural R&D by national governments. Sustainable financial and political support for agricultural R&D is crucial, as is the creation of attractive investment climates for private investors, if the challenges of sustainable economic and social development are to be met. In particular, without sustainable funding for agricultural R&D, low-income, agriculture-dependent countries will continue to struggle in poverty.

Quantitative information is fundamental to understanding the contribution of agricultural S&T to agricultural growth. Indicators derived from such information allow the performance, inputs, and outcomes of agricultural S&T systems to be measured, monitored, and benchmarked. Up-to-date information is a critical tool to interpreting the current status and direction of national agricultural

4. For detailed information on these funding mechanisms and country implementations see Echeverría and Beintema (2009) and ASTI's regional reports (Beintema and Stads 2006, 2008b; Stads and Beintema 2009).

research systems in developing countries. Regular collection of agricultural S&T capacity and investment data is therefore essential in order to keep this information up-to-date.

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