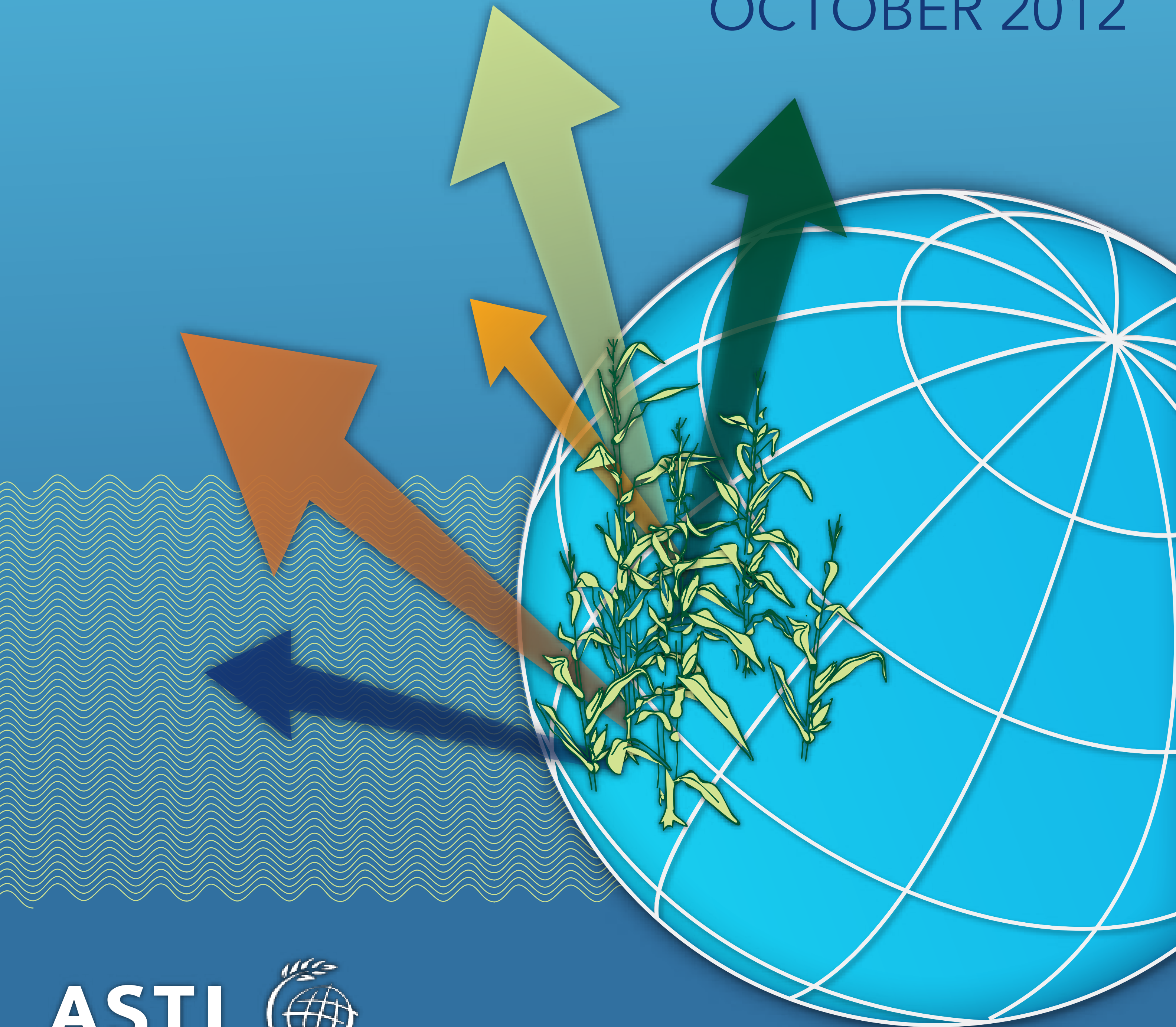
ASTI GLOBAL ASSESSMENT OF AGRICULTURAL R&D SPENDING

Developing Countries Accelerate Investment

OCTOBER 2012



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ASTI Global Assessment of Agricultural R&D Spending

Developing Countries Accelerate Investment

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About IFPRI

The International Food Policy Research Institute (IFPRI) was established in 1975 to identify and analyze alternative national and international strategies and policies for meeting food needs of the developing world on a sustainable basis, with particular emphasis on low-income countries and on the poorer groups in those countries. While the research effort is geared to the precise objective of contributing to the reduction of hunger and malnutrition, the factors involved are many and wide-ranging, requiring analysis of underlying processes and extending beyond a narrowly defined food sector. The Institute's research program reflects worldwide collaboration with governments and private and public institutions interested in increasing food production and improving the equity of its distribution. Research results are disseminated to policymakers, opinion formers, administrators, policy analysts, researchers, and others concerned with national and international food and agricultural policy.

IFPRI is a member of the CGIAR Consortium.

www.ifpri.org

About ASTI

The Agricultural Science and Technology Indicators (ASTI) initiative compiles, analyzes, and publishes primary 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

About GFAR

The Global Forum on Agricultural Research (GFAR) is a multistakeholder-led initiative that serves as an open and inclusive forum for dialogue and action on strategic issues in agricultural research and development (R&D). It facilitates and promotes cost-effective partnerships and strategic alliances among agricultural R&D stakeholders in their efforts to alleviate poverty, increase food security, and promote the sustainable use of natural resources.

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Acknowledgments

This publication was developed with funding from the Bill & Melinda Gates Foundation, the Global Forum for Agricultural Research, and the International Food Policy Research Institute. The authors thank the Asia-Pacific Association of Agricultural Research Institutions, the Forum for the Americas on Agricultural Research and Technology Development, the Association of Agricultural Research Institutions in the Near East and North Africa, and numerous country collaborators that participated in the national survey rounds; without their commitment, this publication would not have been possible. The authors also thank Michael Rahija, Kathleen Flaherty, Mary-Jane Banks, and colleagues in IFPRI's Communications Division for their excellent help in preparing this publication.

The first Global Conference on Agricultural Research for Development (GCARD) in 2010 catalyzed a plan to transform agricultural research and development (R&D) around the world. The resulting GCARD Roadmap states that such transformation can only be achieved by greatly increasing institutional, human, and financial resources; moreover, it recommends a regularized process of monitoring these resources on behalf of all stakeholders (CGIAR and GFAR 2011).[1] The Agricultural Science and Technology Indicators initiative (ASTI), facilitated by the International Food Policy Research Institute (IFPRI), is the only international initiative dedicated to fulfilling this need. ASTI, with contributions from the US Department of Agriculture's Economic Research Service (USDA-ERS), has prepared this global assessment of agricultural R&D spending as an input into GCARD 2012. The findings are of particular value because they incorporate new primary data for 2000–2008.

Compiling accurate, up-to-date, and consistent information on global patterns of public agricultural R&D investments requires significant, long-term human and financial resources. For some countries, no reliable information on public agricultural R&D exists, whereas for others, the available information is outdated, irregular, or incomplete. Importantly, spending patterns can be highly dynamic over time, as recent ASTI publications have shown (Beintema and Stads 2011; Stads 2011), so global estimates based on simple estimations and extrapolations need to be made with caution. ASTI has determined that 2008 is the latest year for which sufficiently reliable data are available to support an accurate assessment of public agricultural R&D spending at the global level (Box 1). Contingent on the availability of resources, ASTI plans to update its datasets in a number of regions in order to provide a global assessment to 2012 in time for GCARD 2014.[2]

Global Trends in Public Agricultural R&D Spending

In 2008, global public spending on agricultural R&D totaled $31.7 billion in inflation-adjusted, purchasing power parity (PPP) dollars.[3] Expenditures were split roughly evenly between high-income countries and low- and middle-income countries, hereafter referred to as "developed" and "developing" countries, respectively (Figure 1). Public agricultural R&D spending in China, India, and Brazil—the three top-ranked countries in terms of public agricultural R&D spending in the developing world—accounted for one-quarter of global spending and half of combined spending in developing countries. Africa south of the Sahara, other Asia–Pacific countries (excluding China and India), other Latin American and the Caribbean countries (excluding Brazil), West Asia and North Africa, and eastern Europe and the former Soviet States each accounted for only 3 to 6 percent of global public spending on agricultural R&D in 2008.

Following a decade of slowing growth in the 1990s, global agricultural R&D spending increased by 22 percent during the 2000–2008 period, from $26.1 to $31.7 billion in 2005 PPP prices (Figure 2). This corresponds with average growth of 2.4 percent per year, about the same as the 1980s rate (Figure 3). Accelerated R&D spending by China and India accounted for close to half of the global increase of $5.6 billion during 2000–2008. Other middle-income countries (particularly Argentina, Brazil, Iran, Nigeria, and Russia) also

1 The need for better assessments and continuous monitoring of agricultural R&D investments and capacities has also been emphasized in a number of other recent reports and meetings addressing food security and related issues, including papers prepared for the 2012 G8 and G20 Summits (US Department of State 2012 and FAO and OECD 2012).

2 As of September 2012, ASTI's primary data collection encompasses Africa and South and West Asia. Additional funding is needed to expand these activities to Latin America and the Caribbean, Central Asia, and Southeast Asia.

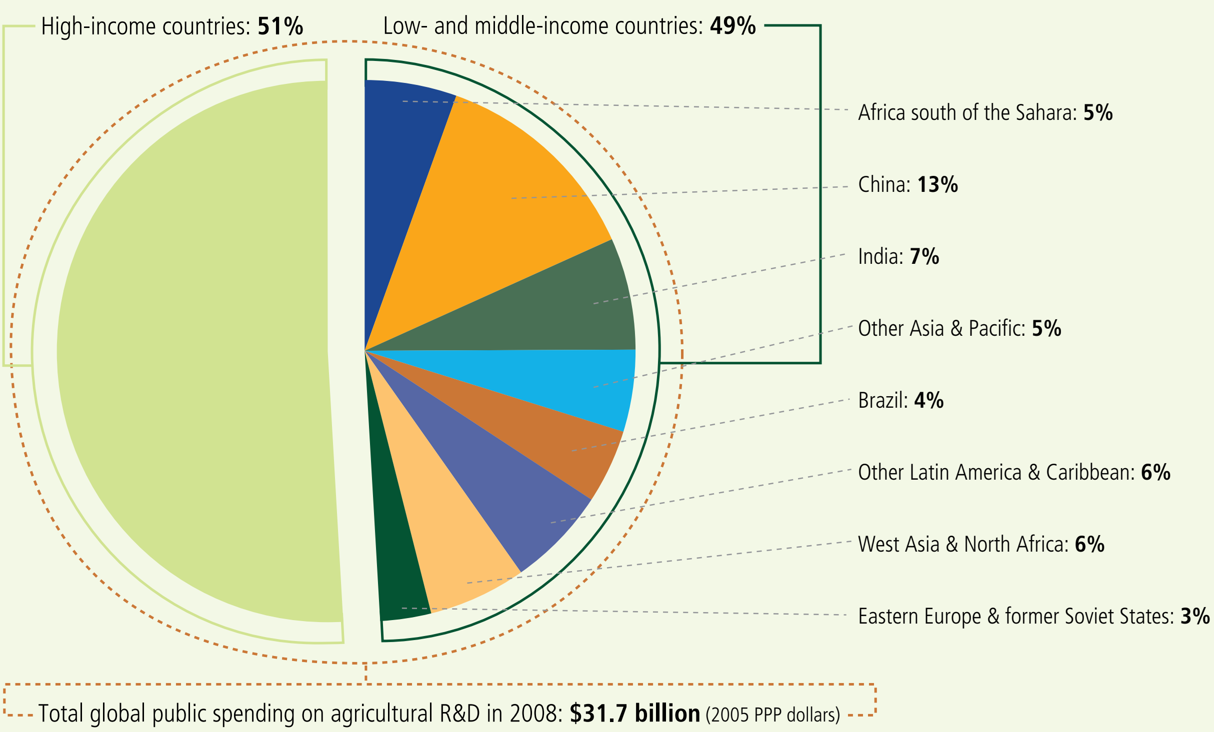
3 Unless otherwise stated, all dollar values in this document are based on 2005 PPP exchange rates, which reflect the purchasing power of currencies more effectively than do standard exchange rates because they compare the prices of a broader range of local—as opposed to internationally traded—goods and services. The public sector is defined, in this context, as government, higher education, and nonprofit agencies engaged in agricultural research. ASTI measures financial resources on a "performer" basis, meaning the entity undertaking the research, not the entity or entities funding it.

1

ASTI's recent collaborative partners and secondary-data sources

ASTI collects primary data for low- and middle-income countries through national institutional surveys and detailed quantitative data on a large number of countries in Africa south of the Sahara and South Asia. While agricultural R&D spending data for these regions are of high quality and up-to-date through 2008, significant gaps remain for other metrics and regions, both by location and across time. In efforts to fill some of the geographical gaps for Southeast Asia, Latin America and the Caribbean, and the Middle East and North Africa, ASTI has been collaborating with the Global Forum for Agricultural Research (GFAR), the Asia–Pacific Association of Agricultural Research Institutions (APAARI), the Forum for the Americas on Agricultural Research and Technology Development (FORAGRO), and the Association of Agricultural Research Institutions in the Near East and North Africa (AARINENA) to collect additional data. ASTI is also currently collaborating with the Central Asia and the Caucasus Association of Agricultural Research Institutions (CACAARI), but survey rounds for this region have yet to be completed.

Figure 1. Global public spending on agricultural R&D by major country or region and by income status, 2008



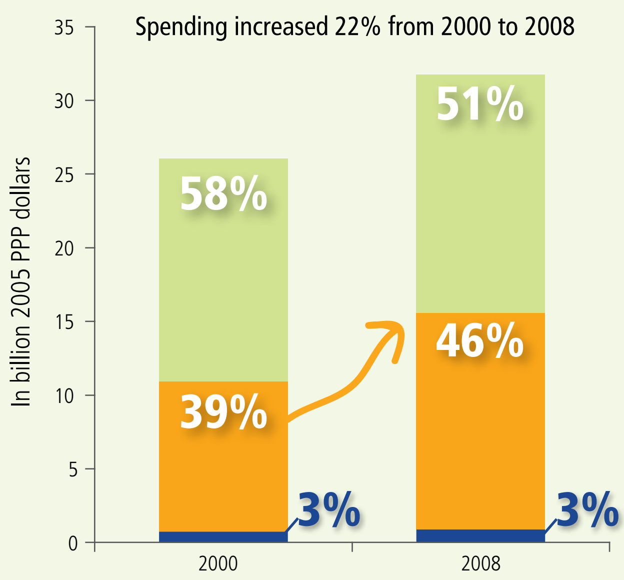
Sources: ASTI 2012, Eurostat 2012, OECD 2012, and various country-level secondary resources.

Notes: Coverage includes 179 countries categorized by income group using the World Bank's 2012 classifications. Regional totals were aggregated from national totals and represent 89 percent of Africa south of the Sahara, 99 percent of other Asia–Pacific countries, 87 percent of other Latin American and Caribbean countries, 86 percent of West Asia and North Africa, 55 percent of eastern Europe and the former Soviet States, and 96 percent of high-income countries. Countries for which no macroeconomic data were available (such as Cuba, Haiti, North Korea, and Somalia) were excluded. More information on data sources, estimation procedures, and country/regional classifications is available at www.asti.cgiar.org/globaloverview.

In addition to its primary data collection activities, ASTI also uses secondary data sources for comparative and other purposes. For most high-income countries and eastern European and former Soviet Union states, public spending data were derived from the Organisation for Economic Cooperation and Development (OECD) and the European Union's Eurostat, although other secondary sources were used for a number of high-income countries—including France, Japan, and the United States—for which data were prepared by USDA-ERS. Data for China and Thailand, and more recent data for the Philippines, were derived from national science and technology statistics. Data from the Network for Science and Technology Indicators (RICYT) were used to calculate 2007–2008 data for a few smaller Latin American countries; finally, data on public R&D spending were estimated for a number of other countries, generally accounting for a small portion of regional totals. Estimates of agricultural R&D spending by the private sector were prepared by USDA-ERS.

Note that more detailed data, graphs, and tables covering the 179 countries in ASTI's global dataset have been specifically developed to accompany this brief and are available (together with further details on data sources and estimation procedures) at www.asti.cgiar.org/globaloverview.

Figure 2. Drivers of increased spending on global agricultural R&D, 2000–2008



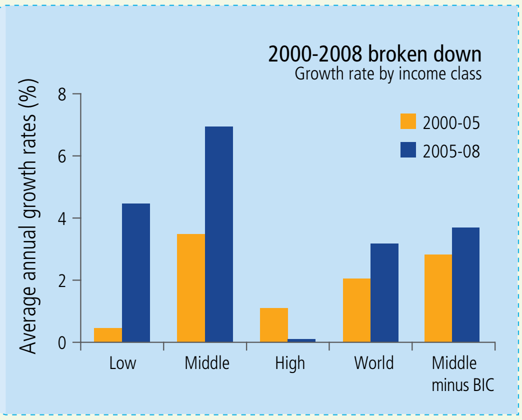
Main drivers of $5.6 billion growth (2005 PPP $)

$2.1 billion	China
$0.6 billion	India
$0.5 billion	United States
+/- $0.2 billion each	Brazil, Argentina, Iran, Japan, Nigeria, Russia

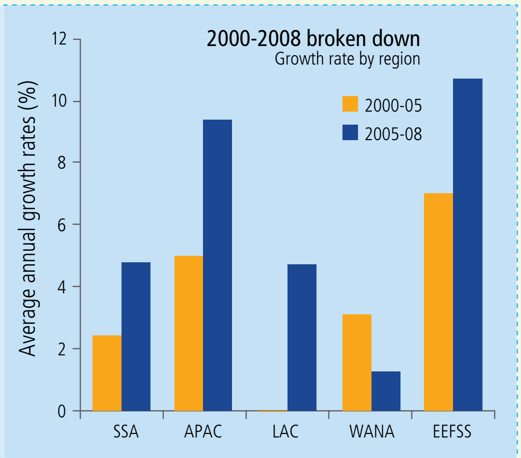
Sources/Notes: See Figure 1.

Figure 3. Average annual agricultural R&D spending growth rates, 1980s, 1990s, and 2000–2008

Growth rates by income class	1980-1990	1990-2000	2000-2008
Low	3.6	0.5	2.1
Middle	2.7	3.0	4.4
High	2.0	1.3	0.8
World	2.3	1.9	2.4
Middle minus BIC	1.7	2.4	3.2



Growth rates by region low and middle income	1980-1990	1990-2000	2000-2008
SSA	0.3	-0.01	2.8
APAC	4.9	4.7	5.8
LAC	1.5	1.2	2..1
WANA	– –	– –	2.3
EEFSS	– –	– –	8.6



Sources: See Figure 1.

Notes: See Figure 1. BIC = Brazil, India, China; SSA = Africa south of the Sahara; APAC = Asia–Pacific countries; LAC = Latin America and Caribbean; WANA = West Asia and North Africa; EEFSS = Eastern Europe and former Soviet States. Compound yearly growth rates were calculated using the least-squares regression method. Growth rates by income group include estimated spending trends for WANA and EEFSS. Regional growth rates exclude high-income countries in these regions (for example, Japan and South Korea in the APAC region). Data for the 1980s and 1990s were not available for WANA and EEFSS.

significantly increased their spending on public agricultural R&D during this period, and collectively accounted for one-fifth—or $1.2 billion—of total global spending growth. Interestingly, most of the growth in public agricultural R&D spending in developing countries occurred during the 2005–2008 period. In low-income countries, R&D spending grew by 2.1 percent per year during 2000–2008, driven largely by increases in the larger East African countries—Ethiopia, Kenya, Tanzania, and Uganda—after a decade of stagnation in the 1990s and early 2000s. R&D growth for middle-income countries was largely driven by China and India. From 2000 to 2008, spending for middle-income countries grew by an average of 4.4 percent per year (2.9 percent per year when calculations exclude China and India). Although recent growth rates in low- and middle-income countries represent an important turnaround from the slowing rates in previous decades, in some cases these increases do not actually translate into more research. In particular, in Africa south of the Sahara most of the funds were directed toward much-needed salary increases and the rehabilitation of infrastructure and equipment after years of neglect (Beintema and Stads 2011).

High-income countries were an exception to the global growth pattern. In fact, their growth rate in public agricultural R&D investment continued to slow. In the 1980s, spending growth in high-income countries averaged 2 percent per year, but it decelerated thereafter, dropping to 1.1 percent per year in the early 2000s and hovering around zero during 2005–2008. In fact, about one-third of the OECD countries spent less on public agricultural R&D in 2008 than they did in 2000. Japan and the United States, with spending levels of $2.7 and $4.8 billion in 2008, respectively, continue to be the top spenders on public agricultural R&D among high-income countries, accounting for half that income group's total and most of the 2000–2008 growth.

While there are fewer low-income countries in recent years than there were in the past, the great majority of the world's poor reside in countries like China, India, and Nigeria, which now fall under the middle-income classification.[4] As of 2012, only 35 countries (27 of which are located in Africa south of the Sahara) were classified as low-income, compared with 67 in 2000 (Kenny and Sumner 2011; World Bank 2012a). The 31 low-income countries included in ASTI's data synthesis accounted for just 3 percent of total global spending in agricultural R&D.[5] This share remained fairly constant from 1981 to 2008 despite the fact that these countries' collective share of world population and total economically active agricultural population rose from 8 to 10 percent and from 12 to 16 percent, respectively (Box 2).

In addition to national agricultural research activities, the CGIAR Consortium makes a significant contribution to agricultural R&D in developing countries. After more than a decade of slow growth, R&D spending by the CGIAR has accelerated since 2006. In 2011, total spending by CGIAR exceeded $700 million, a 41 percent increase from 2006 in inflation-adjusted terms (Box 3).

Comparing public agricultural R&D spending across low- and middle-income regions reveals that all regions increased their agricultural R&D expenditures during 2000–2008. Within regions, however, growth was mostly driven by a few usually larger countries. China and India accounted for more than 90 percent of spending growth in Asia–Pacific. Likewise, about half of growth in agricultural research spending in Africa south of the Sahara was driven by Nigeria, and a further one-third was contributed by Ghana, Tanzania, and Uganda. In Latin America and the Caribbean, Argentina, Brazil, and Mexico accounted for 86 percent of the region's R&D spending growth. Iran and Turkey accounted for about three-quarters of total spending growth in West Asia and North Africa, and among Eastern Europe and the former Soviet States, Russia accounted for nearly half of the growth.

Comparative Assessments of Spending on Agricultural R&D

Absolute spending levels are only one metric for comparing national and regional spending levels. Another way of evaluating a country's agricultural R&D commitment—and of placing it within an international context—is to calculate its agricultural research spending relative to agricultural gross domestic product (GDP). This indicator is commonly known as the research intensity ratio. In 2008, developing countries as a group spent $0.54

The significance of agriculture in low-income countries

2

In general, low-income countries are far more dependent on agriculture than are middle- or high-income countries. In 2008, agriculture accounted for 29 percent of gross domestic product (GDP) in low-income countries on average, compared with just 10 percent for middle-income countries and 1 percent for high-income countries. Thus, agriculture in low-income countries has much greater significance to the national economy and food security, making agricultural growth critical to sustainable and inclusive economic growth. This is only compounded by the reality that populations in many of these countries will continue to grow at high rates into the future. As a major contributor to growth, sustainable investments in agricultural R&D in these countries and regions—both to adapt and disseminate technologies developed elsewhere and to address unique local needs—remain essential.

4 The World Bank publishes classifications on July 1 each year, based on average gross national income (GNI) per capita for the previous year. Per capita GNIs are US$1,025 or less for low-income countries; US$1,026 to US$4,035 for lower middle-income countries; US$4,036 to US$12,475 for upper middle-income countries; and greater than US$12,475 for high-income countries (World Bank 2012a).

5 Afghanistan, Haiti, the Republic of Korea, and Somalia were excluded due to a lack of World Bank data (2012b).

WHAT IS AGRICULTURAL R&D SPENDING?

ACTORS

- GOVERNMENT
- HIGHER EDUCATION
- PRIVATE

AREAS

- CROPS
- LIVESTOCK
- NATURAL RESOURCES

GLOBAL PUBLIC SPENDING

↑ 22%

2000: $26.1 BILLION

2008: $31.7 BILLION

$15.6 BILLION — DEVELOPING

$16.1 BILLION — DEVELOPED

In inflation–adjusted 2005 prices

GLOBAL PRIVATE SPENDING

↑ 26%

2000: $14.4 BILLION

2008: $18.2 BILLION

	AGRICULTURAL	FOOD PROCESSING
2000	$7.5 BILLION	$6.9 BILLION
2008	$8.3 BILLION	$9.9 BILLION

Developed countries drive private growth

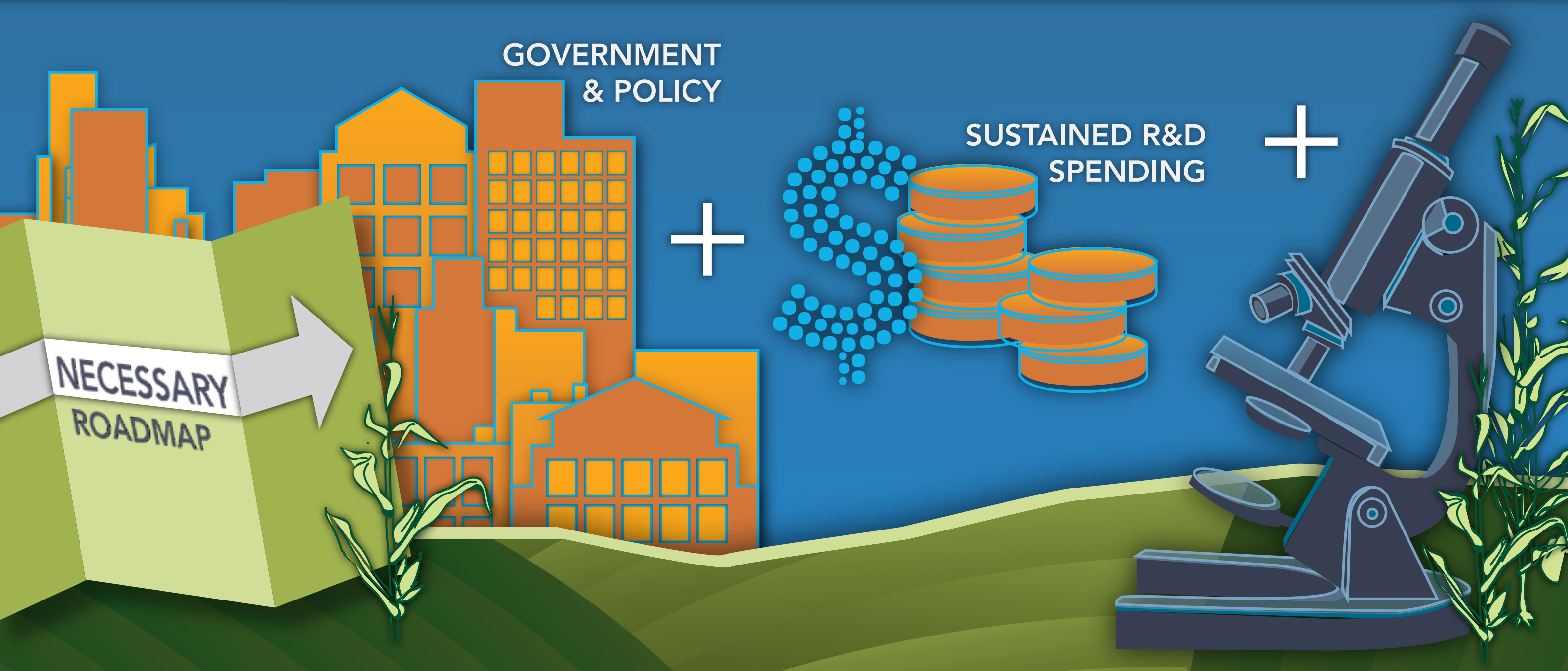
2008

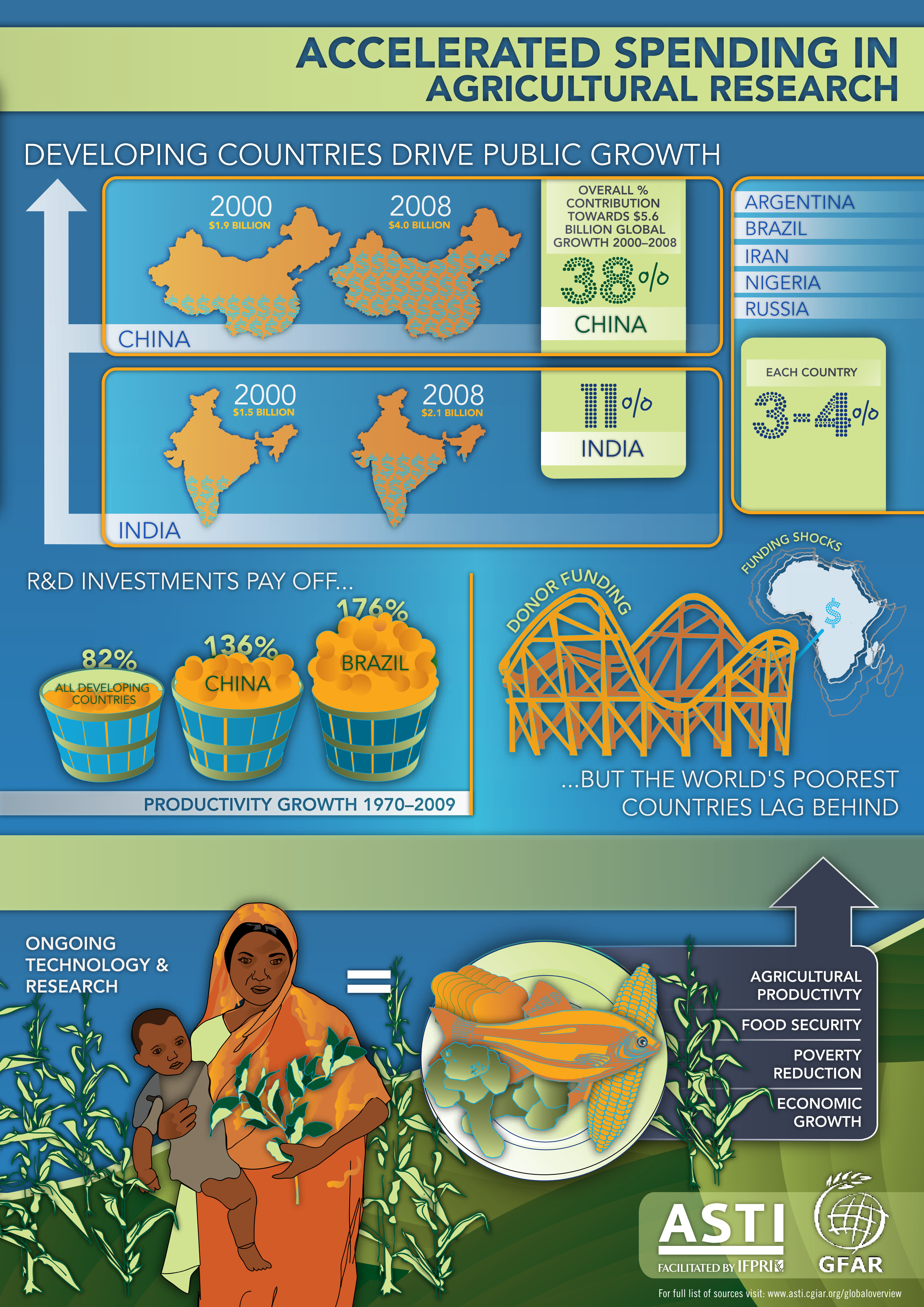
79% PUBLIC

21% PRIVATE

Excluding food processing R&D

WHY DOES RESEARCH INVESTMENT MATTER?




ACCELERATED SPENDING IN AGRICULTURAL RESEARCH
DEVELOPING COUNTRIES DRIVE PUBLIC GROWTH
2000
$1.9 BILLION
2008
$4.0 BILLION
CHINA
OVERALL % CONTRIBUTION TOWARDS $5.6 BILLION GLOBAL GROWTH 2000–2008
38%
CHINA
2000
$1.5 BILLION
2008
$2.1 BILLION
INDIA
11%
INDIA
ARGENTINA
BRAZIL
IRAN
NIGERIA
RUSSIA
EACH COUNTRY
3–4%
R&D INVESTMENTS PAY OFF...
82%
ALL DEVELOPING COUNTRIES
136%
CHINA
176%
BRAZIL
PRODUCTIVITY GROWTH 1970–2009
DONOR FUNDING
FUNDING SHOCKS
$
...BUT THE WORLD'S POOREST COUNTRIES LAG BEHIND
ONGOING TECHNOLOGY & RESEARCH
=
AGRICULTURAL PRODUCTIVTY
FOOD SECURITY
POVERTY REDUCTION
ECONOMIC GROWTH
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(2005 PPP) on public agricultural R&D for every $100 of agricultural GDP; corresponding averages were $0.44 for low-income countries and $0.55 for middle-income countries (Figure 5). Across regions, the average intensity ratio ranged from $0.42 in Asia–Pacific to $1.10 in Latin America and the Caribbean.

The average intensity ratio for the developing countries as a group—and for individual developing regions—has remained fairly constant over time. In other words, growth in R&D spending roughly tracked growth in agricultural GDP in developing countries. In high-income countries, in contrast, public agricultural R&D spending for every $100 (2005 PPP) of agricultural GDP has increased steadily since the early 1980s, reaching $2.63 in 2000 and $3.07 in 2008. The higher intensity ratio for high-income countries reflects a number of factors:

1. As countries develop and their economies become more knowledge-based, R&D intensity ratios tend to rise in all segments of the economy and in both the public and private sectors.

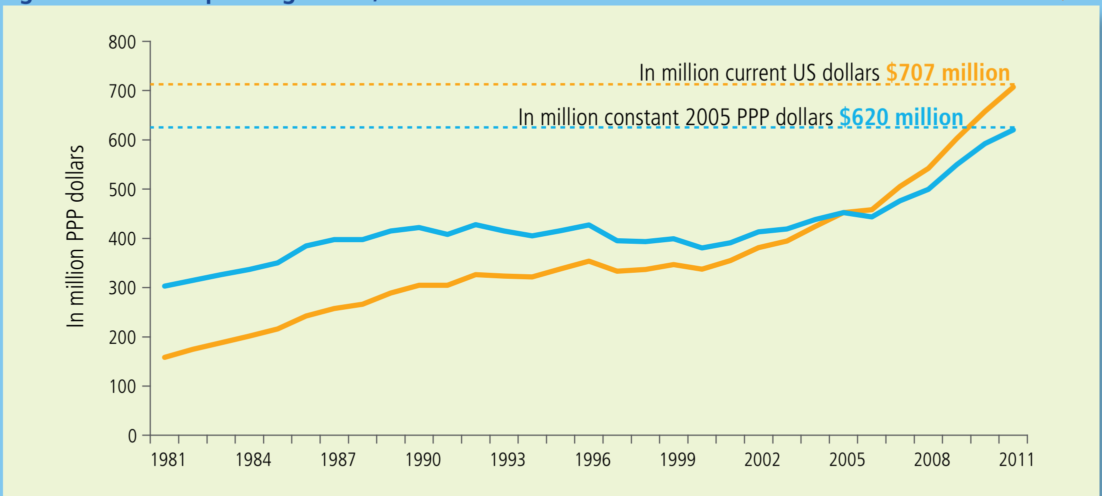
3

Agricultural R&D spending by the CGIAR Consortium

Internationally performed public agricultural research is mostly undertaken by the 15 centers of the CGIAR Consortium, a global research partnership for a food-secure future. Combined, these centers and system offices spent more than 700 million PPP dollars in 2011, equivalent to 624 million PPP dollars in 2005 prices. Like global public and private agricultural R&D spending, CGIAR spending increased substantially during 2000–2008. Its spending rose by 31 percent during that time (compared with 21 percent for global public spending) and increased by an additional 25 percent during 2008–2011 (in inflation-adjusted dollars). Although the CGIAR plays an important role in agricultural R&D in developing countries, it accounts for only a small share of global public agricultural R&D spending. In 2008, CGIAR spending as a share of total global public agricultural R&D spending amounted to a mere 1.5 percent (3.1 percent, if high-income countries are excluded).

CGIAR expenditures by region reveal some interesting shifts overtime. In 1990, 42 percent of CGIAR spending was allocated to Africa south of the Sahara. By 2007, this share rose to 47 percent and has remained relatively constant since. When juxtaposing CGIAR spending trends against public agricultural R&D spending by region (excluding high-income countries), the relatively high ratio for Africa south of the Sahara stands out. In 2008, CGIAR spending as a share of the region's total public agricultural R&D spending totaled 11 percent, which is more than four times higher than CGIAR shares in other developing regions. While the ratio dropped by more than half in Asia–Pacific countries and West Asia and North Africa and by one-third in Latin America and Caribbean from 1990 to 2008, it has not changed much in Africa south of the Sahara (Figures 4a–4c).

Figure 4a. CGIAR spending trends, 1981–2011



2. Countries at or near the productivity frontier tend to emphasize basic science to advance the frontier and maintenance research to sustain productivity at a high level.

3. Research agendas for public institutions tend to broaden as national income levels rise (reflecting changing preferences); as a result, greater emphasis is given to issues like environmental protection, food safety, and rural well-being, whereas less emphasis is given to issues like raising farm production.

Developing countries, on the other hand, focus more of their resources on applied research to facilitate closing yield or productivity gaps and adapting technologies to local conditions. Nevertheless, small developing countries are often observed to have higher research intensities based on their inability to take advantage of scale economies. To be effective, national research systems may need to establish some minimum capacities across all relevant disciplines and major commodities, regardless of the size of the agricultural sector the system is

Figure 4b. Allocation of CGIAR spending by region, 1990 and 2008

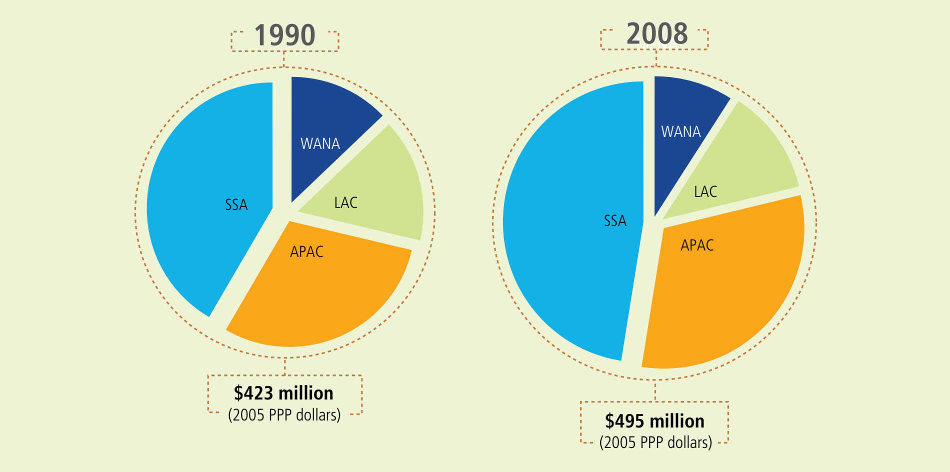
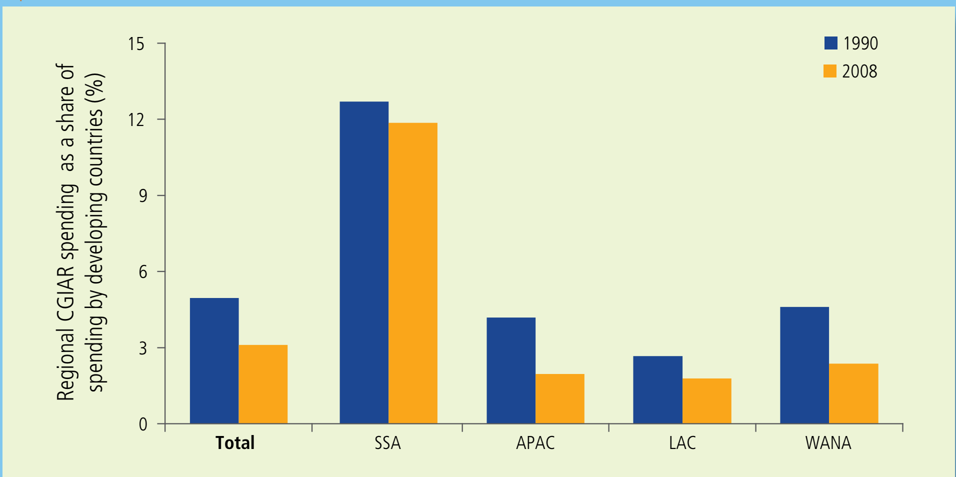


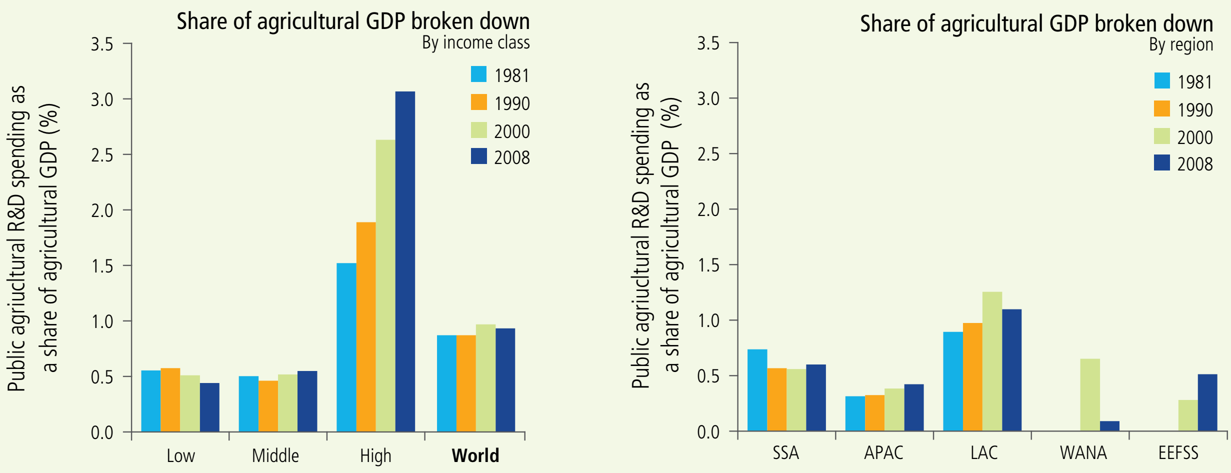
Figure 4c. Regional CGIAR spending as a share of developing countries public agricultural R&D spending by region, 1990 and 2008



Source: CGIAR various years.

Notes: PPP and US dollar values are equal when presented in 2005 prices. The Eastern Europe and former Soviet States region is included in CGIAR data but excluded from spending data for developing countries. SSA = Africa south of Sahara; APAC = Asia–Pacific countries; LAC = Latin America and the Caribbean; WANA = West Asia and North Africa.

Figure 5. Intensity ratios by income group and region, 1981, 1990, 2000, and 2008



Sources: See Figure 1. For agricultural GDP, see World Bank 2012b.

Notes: SSA = Africa south of the Sahara; APAC = Asia–Pacific countries; LAC = Latin America and the Caribbean; WANA = West Asia and North Africa; EEFSS = Eastern Europe and former Soviet States. Intensity ratios by income group include estimated spending trends for WANA and EEFSS. Regional growth rates exclude high-income countries within that region (for example, Japan and South Korea in the APAC region). Data for 1981 and 1990 were not available for WANA and EEFSS.

Table 1. Comparing compounded annual growth rates, 2000–2008

Income class	Agricultural R&D (%)	Agricultural GDP (%)
Low-income countries	2.0	2.2
Middle-income countries	4.2	3.7
High-income countries	0.8	–1.4

Region	Agricultural R&D (%)	Agricultural GDP (%)
Africa south of the Sahara	2.8	1.9
Asia–Pacific countries	5.8	5.0
Latin American & Caribbean	2.1	3.3
West Asia & North Africa	2.3	1.9
Eastern Europe & Former Soviet States	8.6	–0.5

Sources: For public agricultural R&D spending, see Figure 1; for agricultural GDP, World Bank 2012b.

designed to serve. For example, while China and India have had lower research intensity ratios than many countries in Africa south of the Sahara, their research systems are better equipped to address farmers' scientific and technological challenges due to their larger absolute size and greater research capacities.[6]

Due to their limitations, intensity ratios should neither be used as the sole measure of public agricultural R&D spending levels across countries nor as a target to be reached. The ratios do not take into account the policy and institutional environment within which agricultural research occurs, and they cannot account for the influx of foreign technologies. The interpretation of intensity ratios therefore requires consideration of a complex and fluctuating set of factors, including investment growth, human resource capacity, and infrastructure. Intensity ratios don't always reflect increased agricultural R&D spending; they can also reflect declining or stagnating agricultural output. For example, while the rapidly rising intensity ratio of high-income countries in recent years

6 Another limitation is that official agricultural GDP figures do not fully reflect agriculture's importance. A number of the more advanced middle-income countries conduct research in areas related to agribusiness, including those classified by the World Bank as "manufacturing" rather than "agriculture," excluding them from official agricultural GDP data. The inclusion of agribusiness-related R&D spending therefore leads to an overestimation of these countries' agricultural R&D intensity ratios.

can be explained in part by increased R&D investment (0.8 percent per year from 2000–2008), falling agricultural GDP figures (of –1.4 percent per year) actually had an even larger impact (Table 1).

Intraregional Variation in Spending Levels and Trends

As previously mentioned, growth in regional spending levels during 2000–2008 was driven by China, India, and a handful of other larger developing countries; however, the regional averages mask considerable variations across countries, some of which warrant a closer look.

AFRICA SOUTH OF THE SAHARA

During 2000–2008, close to half the African countries for which time-series data were available recorded negative yearly growth in public agricultural R&D spending, ranging from –0.2 to –12.0 percent per year; these are especially low considering that overall spending in Africa south of the Sahara actually increased by about one-third during the same timeframe. Declining spending levels were particularly severe in francophone West and Central Africa. In countries like Burkina Faso, Guinea, Senegal, and Togo, falling expenditure levels resulted mainly from the completion of large donor-funded projects, often financed through World Bank loans. Some countries in Africa south of the Sahara have such low investment and capacity levels that the impact of agricultural R&D on rural development and poverty reduction is questionable at best (Beintema and Stads 2011).

ASIA–PACIFIC

A similar divide between countries exhibiting positive and negative growth is apparent in the Asia–Pacific region. While China and India were the main drivers of agricultural R&D spending growth in that region, other emerging economies like Indonesia and Vietnam also recorded significant growth in R&D spending between 2000 and 2008. Nevertheless, expenditure levels in some of the region's smaller low- and lower middle-income countries—including Cambodia, Lao PDR, Nepal, and Papua New Guinea—all reported stalling or declining R&D spending during 2000–2008, indicating that the region's poorer countries are falling behind in their ability to generate new technologies and varieties.

LATIN AMERICA AND THE CARIBBEAN

Several of the region's poorer, agriculture-dependent countries—such as El Salvador, Guatemala, and Paraguay—recorded sharp cuts in their agricultural research expenditures and intensity ratios during 2000–2008, whereas the more economically advanced countries (Argentina, Brazil, and Mexico) recorded growth. Moreover, most of the region's poorest and most technologically challenged countries are located in tropical zones, and, unlike some of their more advanced neighbors in temperate zones, are less able to take advantage of spillovers of technologies and varieties generated by high-income countries with complementary agroclimatic conditions (Stads and Beintema 2009). Technological spillovers from Brazil, however, do play an increasingly important role in tropical countries around the world.

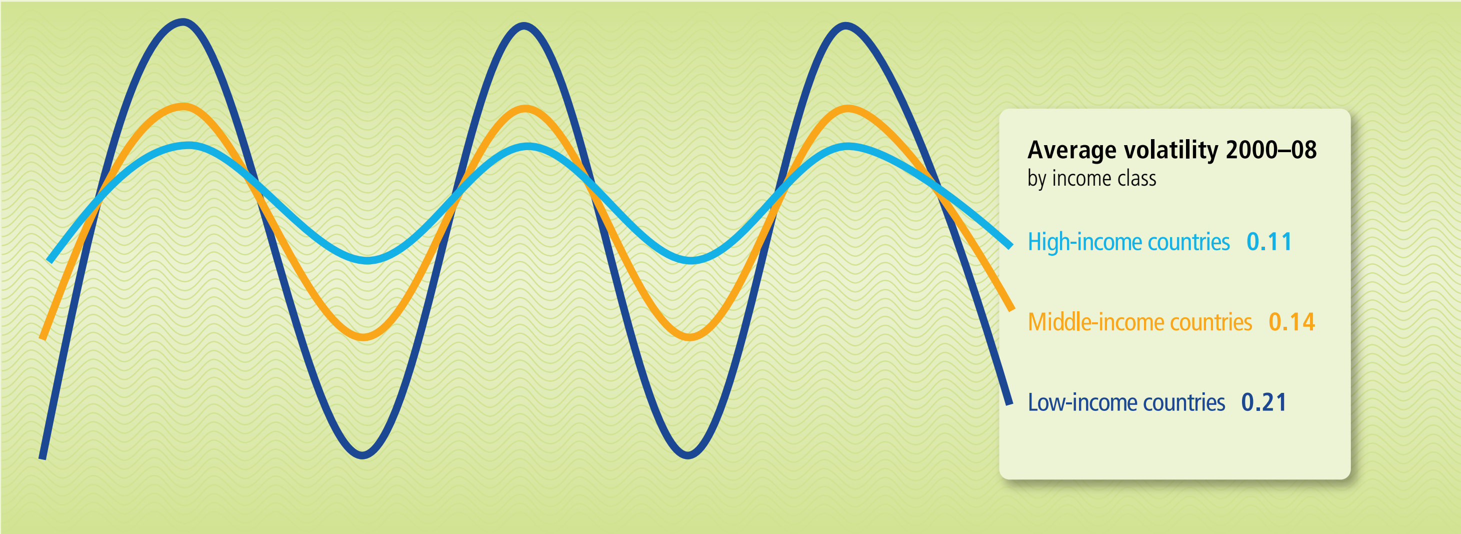
R&D Spending Volatility

The inherent lag from the inception of a study to the adoption of a new technology or crop variety demands that financial resources are sustained and stable. In many countries, however, funding for agricultural R&D is far from stable, leading to severe fluctuations in R&D expenditure levels from one year to the next. Volatility coefficients, which quantify shifts in agricultural R&D spending levels, are useful tools for assessing funding volatility across countries and regions and providing an insight into the main drivers of funding shocks. Volatility coefficients were calculated for 85 countries worldwide, based on complete time-series data on agricultural R&D expenditures for the 2000–2008 period. Countries with few or no changes in yearly spending levels or those with steady (positive or negative) growth have low volatility coefficients. In contrast, countries with erratic fluctuations in spending levels from one year to the next have high volatility coefficients. A value of 0 indicates "no volatility," whereas values above 0.20 indicate relatively high volatility.[7]

An analysis of average volatility in the world's high-, middle-, and low-income countries reveals an interesting division. During 2000–2008, yearly agricultural R&D spending levels in low-income countries (0.21) were

7 For more details about methodology used, see Stads (2011).

Figure 6. Agricultural R&D spending volatility across income groups and regions, 2000–2008



Sources: See Figure 1.

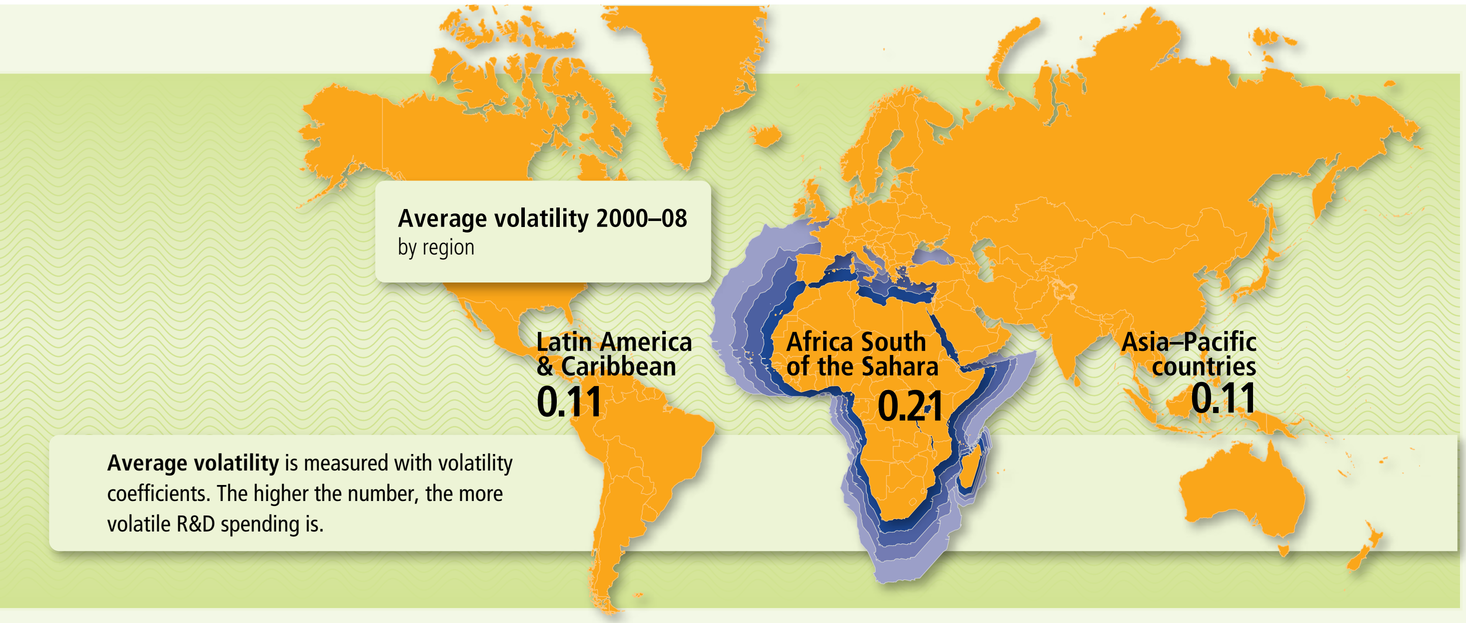
Notes: For a more detailed overview of how volatility coefficients are calculated, see Stads 2011.

twice as volatile as those of high-income countries (0.11) and considerably more volatile than those of middle-income countries (0.14) (Figure 6). In addition, average volatility in Africa south of the Sahara (0.21) proved to be much higher than in other developing regions. Countries like Burkina Faso, Gabon, Mauritania, and Tanzania recorded volatility coefficients as high as 0.40, whereas average R&D spending volatility in Latin America and the Caribbean (0.11) and Asia–Pacific (0.11) was significantly lower by comparison and, in fact, on par with levels in OECD countries (0.11).

Although volatility is driven by a variety of factors across countries, detailed funding data reveal that the main driver of volatility in Africa south of the Sahara has been the short-term, project-oriented nature of donor and development bank funding (Stads 2011). Agricultural R&D agencies in Africa south of the Sahara—and particularly those in the region's low-income countries—are more dependent on funding from donors and development banks than their counterparts in other developing regions, and this type of funding has shown considerably greater volatility in the past decade compared with government and other sources. In the absence of sustained levels of government funding, numerous R&D agencies across Africa south of the Sahara (but also in low-income and lower middle-income countries in Asia–Pacific and Central America) have reverted to financial crisis at the completion of large donor-funded projects. This reality forces them to cut research programs and lay off staff, eliminating much of the hard-won progress they just made. In contrast, Brazil and China offer evidence of the value and impact of sustained levels of government funding for agricultural research over time (Box 4).

Human Resource Capacity Challenges

Human resource capacity refers to the quantity and quality of scientific and technical personnel employed in national research systems. It is difficult to arrive at an estimate of the human resource capacity in agricultural R&D worldwide because the necessary data are not available for all regions, and different countries have different definitions of what constitutes an agricultural researcher. That said, for the period 2000–2008, the total number of agricultural research staff increased by 25 percent in Africa south of the Sahara; by 16 percent in Asia–Pacific, excluding China, India, and Thailand; and by 5 percent in Latin America and the Caribbean. As always, these regional totals are largely driven by a handful of large countries and mask some major cross-country differences within regions. Despite the increase in the



total number of staff across developing regions, human resource capacity levels actually declined in both China and India over time. Reforms beginning in the 1990s intended to improve efficiency precipitated reduced staffing levels at government agencies in China (Chen, Flaherty, and Zhang 2012), whereas the falling levels in India were the result of reduced recruitment of research staff at state agricultural universities and a shift away from research in favor of teaching (Pal, Rahija, and Beintema 2012).

Despite positive developments in agricultural R&D staffing levels in many developing regions, a large number of them continue to face important capacity challenges. In some countries, long-term public-sector recruitment restrictions have skewed the average age of scientists to the higher end of the spectrum and left agencies vulnerable as their senior staff approach retirement without a clear line of succession. This problem is particularly severe in francophone West Africa, but also in parts of Latin America and the Caribbean as well as Nepal. Government institutions in countries that have been able to lift long-term recruitment bans have often had to contend with influxes of young, inexperienced scientists (qualified with only bachelor's or equivalent degrees) in need of appropriate training but lacking mid-level mentors to guide them. Attracting and retaining qualified research staff is a major challenge across developing countries. Low salaries and conditions of service in public agricultural R&D institutes have been the main cause of high staff turnover and "brain drain" to the private sector, CGIAR, or abroad. Moreover, in-country postgraduate training opportunities are often limited. This is especially true for small developing countries that are further challenged by low human resource capacity and funding volatility, and lack of ability to take advantage of economies of scale and scope. The lack of a critical mass of well-qualified researchers in small countries highlights the need for regional initiatives that focus on better use of limited resources and the reduction of wasteful duplication. Finally, many developing countries (particularly in West Africa, South Asia, and West Asia) still have relatively low levels of female participation in agricultural R&D and will need to further integrate gender differences into the formulation of related policies.

Private-Sector Involvement in Agricultural R&D

Private investment in R&D focusing on agriculture and food processing increased from $12.9 billion in 1994 to $18.2 billion in 2008. About 45 percent of this amount

4

The impact of sustained government funding for agricultural R&D: Evidence from Brazil and China

Improving agricultural productivity features high on the agenda in both Brazil and China, and both countries have increased their funding for agricultural R&D in recent years. China's public agricultural research spending almost doubled during 2000–2008 and is estimated to have increased by a further 50 percent (or an additional $2 billion dollars in 2005 prices), during 2009–2010 (Figure 7). Brazil has traditionally had one of the most well-established, well-funded research systems in the developing world, but spending levels have fluctuated over the past two decades. In recent years, however, the Brazilian government increased its commitment to agricultural R&D, resulting in an estimated increase in spending of 20 percent during 2008–2011.

Policy and institutional reforms, as well as a strong commitment to research, lifted agricultural productivity in Brazil and China above the rest of the developing world in the 1980s, and both countries have maintained rapid growth ever since (Figure 8). Besides agricultural R&D, reforms have included improved incentives for farmers, macroeconomic stability, relatively strong extension and rural education systems, and improved rural infrastructure and market access (Chen, Flaherty, and Zhang 2012; GHI 2011). As a result of these policies, both countries experienced sustained higher agricultural growth—measured as total factor productivity (TFP). By 2009 (relative to 1970 levels), cumulative TFP growth had increased by 176 percent in Brazil and by 136 percent in China compared with 82 percent for developing countries as a whole.

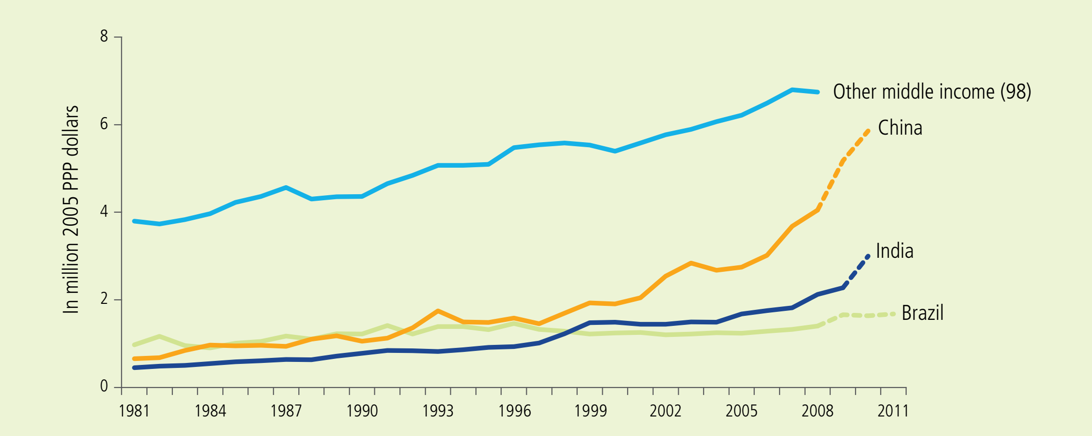
The Indian government has also increased its funding to agricultural research since the late-1990s, but, to date, the country has invested a lower percentage of its agricultural output in research than either Brazil or China, both in absolute terms and as a share of its agricultural GDP. Policy and institutional reforms affecting agriculture have also been less pronounced in India than in the other two countries (Fuglie and Schimmelpfennig 2010).

was directed to R&D related to improving inputs used in agricultural production, whereas the remainder was directed to areas related to food processing and product development (Figure 9). Focusing only on agriculture-related research—so, excluding food processing and product development—global R&D spending by the public and private sectors combined totaled $40.1 billion (PPP) in 2008, of which 79 percent was performed by the public sector and 21 percent by the private sector.[8]

Most of the private-sector R&D was carried out by companies based in OECD countries, but many of these companies maintain experiment stations in developing countries in order to transfer new proprietary technologies to these markets (Fuglie et al. 2011). Information on private-sector involvement in developing countries remains limited, but evidence suggests significant growth in large middle-income countries. In India, agricultural R&D spending by the private sector has increased five-fold since the mid-1990s (Pray and Nagarajan 2012), such that by 2008–2009 it accounted for 19 percent of the country's total (public and private) agricultural R&D spending (Pal, Rahija, and Beintema 2012). Private companies have also become increasingly active in agricultural R&D in China. In 2006, private-sector spending accounted for 16 percent of total agricultural research spending. As indicated, these figures exclude R&D related to food processing, which also plays an important role in China (Hu et al. 2011).

8 ASTI adheres to OECD and World Bank definitions of agriculture, which define food processing and product development as "manufacturing." These two areas are also excluded from official agricultural GDP figures.

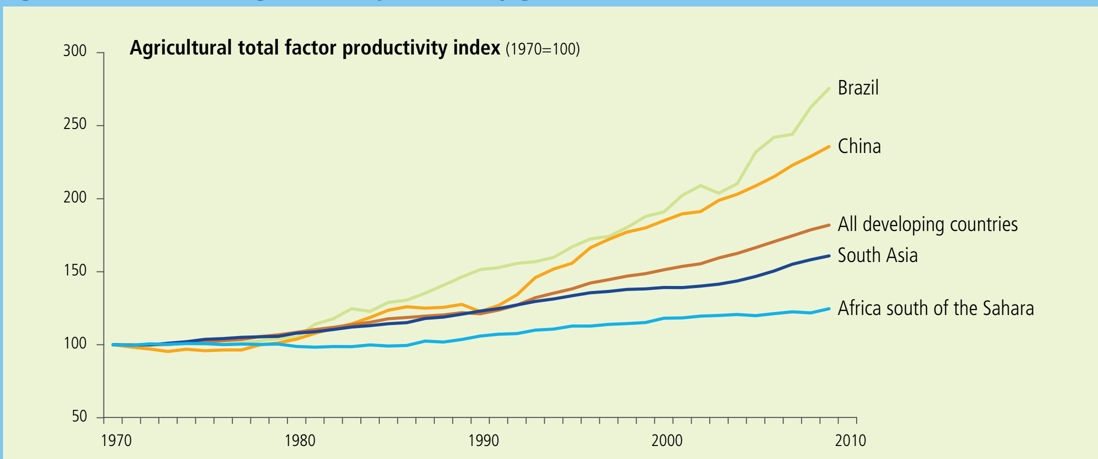
Figure 7. Spending trends in Brazil, China, India, and other middle-income countries, 1981–2011



Sources: ASTI 2012, Embrapa 2012, Eurostat 2012, India various years, NBS and MOST various issues, OECD 2012, and various country-level secondary resources.

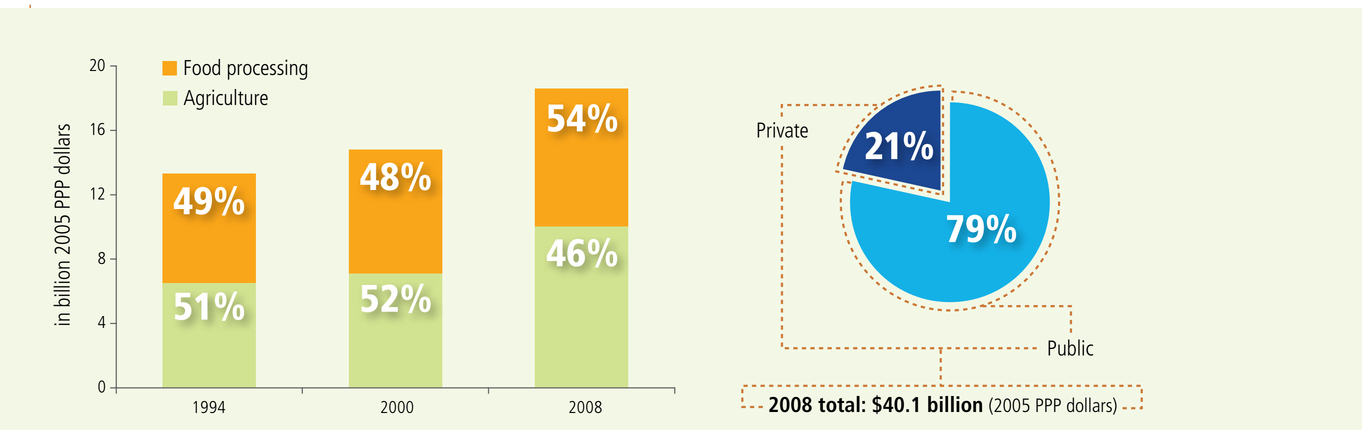
Notes: Dotted lines indicate preliminary estimates; Brazil 2009–11 estimates based on Embrapa data (2012) assuming spending growth at other agencies was half that of Embrapa's; India estimates based on Indian Council of Agricultural Research data and state agricultural universities assuming spending growth at other agencies was half that estimate; China 2009–10 estimates based on assumption that overall agricultural R&D spending grew at the same rate as direct research costs of government spending data (the only data available).

Figure 8. Accelerated agricultural productivity growth in Brazil and China, 1970–2010



Source: Fuglie 2012.

Figure 9. Global private-sector spending in R&D related to agriculture and food processing



Source: Fuglie et al. 2011.

Notes: Private-sector research in agriculture includes combined research spending by seven agricultural input industries (seed/biotechnology, agricultural pesticides, fertilizer, farm machinery, animal health, nutrition, and breeding). Food processing data are presented separately in the bar graph.

Conclusion

Overall, global agricultural R&D spending in the public and private sectors steadily increased between 2000 and 2008. As further proof of positive development, most of this growth was driven by developing countries, since growth in high-income countries stalled. But, spending growth in developing countries was largely driven by positive trends in a number of larger, more advanced middle-income countries—such as China and India—masking negative trends in numerous smaller, poorer, and more technologically challenged countries. Countries in this last group are often highly vulnerable to severe volatility in funding, and hence in spending, which impedes the continuity and ultimately the viability of their research programs. Many R&D agencies in this group lack the necessary human, operating, and infrastructural resources to successfully develop, adapt, and disseminate science and technology innovations.

Agricultural R&D stakeholders, including policymakers, donors, R&D managers, and international development groups, need reliable and up-to-date information on the status and direction of spending and human resource capacity levels. The complex interaction of new global challenges, including the recent food and financial crises and the effects of climate change, highlights the need for a continuous updating of key agricultural R&D indicators. ASTI's role in this area is widely recognized and was discussed in the recent G8 and G20 reports.[9] Through its widespread network of national, regional, and international partners, ASTI continues to monitor agricultural R&D spending levels worldwide and serves as an important implementer of the GCARD monitoring process—assuming ongoing international support is provided.

References

ASTI (Agricultural Science and Technology Indicators). 2012. ASTI database. International Food Policy Research Institute, Washington, DC.

Beintema, N. M., and G. J. Stads. 2011. *African Agricultural R&D in the New Millennium: Progress for Some, Challenges for Many.* IFPRI Food Policy Report. Washington, DC: International Food Policy Research Institute.

Chen, K., K. Flaherty, and Y. Zhang. 2012. *China: Recent Developments in Agricultural R&D*. ASTI Country Note. Washington, DC: International Food Policy Research Institute.

CGIAR. Various years. *Financial Report*. Washington, DC.

CGIAR and GFAR (Global Forum on Agricultural Research). 2011. *The GCARD RoadMap: Transforming Agricultural Research 4 Development (AR4D) Systems for Global Impact*. www.fao.org /docs/eims/upload//290017/The_GCARD__Road_Map_finalized%2020-4-2011.pdf (accessed September 15, 2012).

Embrapa (Brazilian Agricultural Research Corporation). 2012. Financial data. Brasilia.

Eurostat. 2012. Statistics. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database (accessed October 1, 2012).

FAO (Food and Agriculture Organization of the United Nations). 2012. FAOSTAT database. http://faostat3.fao.org/home/index.html (accessed October 1, 2012).

FAO and OECD (Organisation for Economic Co-operation and Development). 2012. *Sustainable Agricultural Productivity Growth and Bridging the Gap for Small-Family Farms: Interagency Report to the Mexican G20 Presidency.* www.oecd.org/tad/ agriculturalpoliciesand-support/50544691.pdf (accessed August 3, 2012).

Fuglie, K. O. 2012. Productivity Growth and Technology Capital in the Global Agricultural Economy. In *Productivity Growth in Agriculture: An International Perspective*, K. O. Fuglie, S. L. Wang, and V. E. Ball, eds. Oxfordshire, England, UK: CAB International.

Fuglie, K. O., and D. Schimmelpfennig. 2010. "Introduction to the Special Issue on Agricultural Productivity Growth: a Closer Look at Large, Developing Countries." *Journal of Productivity Analysis* 33: 169–172.

Fuglie, K. O., P. W. Heisey, J. L. King, C. E. Pray. K. Day-Rubenstein, D. Schimmelpfennig, S. L. Wang, and R. Karmarkar-Deshmukh. 2011. *Research Investments and Market Structure in the Food Processing, Agricultural Input, and Biofuel Industries Worldwide*. ERR-130. Washington, DC: US Department of Agriculture, Economic Research Service.

GHI (Global Harvest Initiative). 2011. *2011 GAP Report: Measuring Global Agricultural Productivity*. Washington, DC.

Hu, R., Q. Liang, C. Pray, J. Huang, and Y. Jin. 2011. Privatization, public R&D policy, and private R&D investment in China's agriculture. *Journal of Agricultural and Resource Economics* 36 (2): 416–432.

India, Government of. Various years. *Agricultural Statistics at a Glance*. New Delhi.

Kenny, C., and A. Sumner. 2011. "How 28 Poor Countries Escaped the Poverty Trap." *The Guardian, Poverty Matters Blog*. July 12. www.guardian.co.uk/global-development/poverty-matters/2011/jul/12/world-bank-reclassifies-28-poor-countries.

NBS (National Bureau of Statistics) and MOST (Ministry of Science and Technology). Various years. *China Statistical Yearbook on Science and Technology*. Beijing: China Statistics Press.

OECD (Organisation for Economic Co-operation and Development). 2002. *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development.* Paris.

________. 2012. OECD Science, Technology and R&D Statistics Database. www.oecd-ilibrary.org/science-and-technology/data/oecd-science-technology-and-r-d-statistics_strd-data-en (accessed April 20, 2012).

Pal, S., M. A. Rahija, and N. M. Beintema. 2012. *India: Recent Developments in Agricultural Research*. ASTI Country Note. Washington, DC, and New Delhi: IFPRI and Indian Council of Agricultural Research.

Pray, C., and L. Nagarajan. 2012. *Innovation and Research by Private Agribusiness in India*. IFPRI Discussion Paper 1181. Washington, DC: International Food Policy Research Institute.

Stads, G. J. 2011. "Africa's Agricultural R&D Funding Rollercoaster: An Analysis of the Elements of Funding Volatility." In *Agricultural R&D: Investing in Africa's Future—Analyzing Trends, Challenges, and Opportunities*. Washington, DC, and Accra: IFPRI and FARA.

Stads, G. J., and N. M. Beintema. 2009. *Public Agricultural Research in Latin America and the Caribbean: Investment and Capacity Trends*. ASTI Synthesis Report. Washington, DC: IFPRI and Inter-American Development Bank.

US Department of State. 2012. *Camp David Accountability Report: Actions, Approach and Results*. Washington, DC. www.state.gov/documents/organization/189889.pdf (accessed August 3, 2012).

World Bank. 2012a. How We Classify Countries. <http://data.worldbank.org/about/country-classifications> (accessed August 3, 2012).

________. 2012b. World Development Indicators & Global Development Finance. <http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2> (accessed April 20, 2012).

9 See footnote 1.

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978-0-89629-802-6