MEASURING AGRICULTURAL RESEARCH INVESTMENTS

A Revised Global Picture

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OVERVIEW

Revised calculations of global agricultural research and development (R&D) spending show that the world is investing less in agricultural research than previously thought. In addition, the agricultural R&D spending of developing countries has been revised downward, with the result that high-income countries as a group still invest more in public agricultural R&D than do developing countries. Developing countries are making up ground, but more slowly than previously estimated.

This brief presents revised investment trends in global agricultural R&D previously published by the Agricultural Science and Technology Indicators (ASTI) initiative. This revision has been prompted by major World Bank adjustments to its comparative pricing of goods and services across countries, expressed in internationally comparable exchange rates known as purchasing power parity (PPP) indexes. These index adjustments have in turn led to downward revisions of global economic growth figures by the International Monetary Fund (IMF), and an upward revision of developing-country poverty estimates by the World Bank. Furthermore, ASTI recently revised its country classifications to reflect increasing diversity among developing countries. The initiative has also produced new estimates of agricultural R&D investments for Latin America and the Caribbean, and a number of other developed and developing countries.

The reduced calculation of total global agricultural R&D spending is largely the result of a downward adjustment of total spending for China and India. The PPP indexes for the United States, Japan, and other high-income countries did not undergo major revisions. However, due to large downward PPP adjustments in many other countries as well as the reclassification of non-OECD high-income countries, the share of high-income countries as a group in 2000 increased to 57 percent.

THE IMPORTANCE OF AGRICULTURAL SCIENCE AND TECHNOLOGY INDICATORS

Successful innovation in agriculture depends on the provision of new and improved technologies that are well targeted; which in turn depend on well-fund agricultural research systems with appropriate research capacity and infrastructure. Current global developments in food prices and climate change further emphasize this point. Given competing demands, investments in agricultural science and technology (S&T) in many developing countries have stagnated over time despite numerous studies repeatedly linking improvements in agricultural productivity with increased investments in agricultural S&T. Furthermore, agricultural S&T systems in many countries have become increasingly complex, requiring the implementation of new organizational structures, increased participation by the higher education and private sectors, and diversification of funding sources.

Quantitative information provides the foundation of our understanding of the important contribution of agricultural S&T in promoting agricultural growth. Indicators based on such information assist in measuring, monitoring, and benchmarking the performance, inputs, and outcomes of agricultural S&T systems (Spielman and Birner 2008).[1] These indicators assist S&T stakeholders formulate policy, setting priorities, and undertake 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 (Tijssen and Hollanders 2006; NEPAD 2007).

RATIONALE FOR REVISING GLOBAL AGRICULTURAL R&D INVESTMENT TRENDS

This revision of global agricultural R&D investment trends, developed by ASTI and reported in the IFPRI Food Policy Report *Agricultural Research: A Growing Global Divide?* (Pardey, et al. 2006), was prompted by a number of concurrent developments:

1. In February 2008, the World Bank released a substantially revised set of cost-of-living data, expressed in internationally comparable exchange rates known as PPP indexes for the year 2005 (World Bank 2008a). These revisions resulted from a benchmark survey round that was more extensive than previous surveys in terms of coverage and methodology. In response, various international organizations amended their macroeconomic estimates. The IMF, for example, lowered its estimate of the 2007 global economic growth rate from 5.2 to 4.7 percent (Elekdag and Lail 2008), and the World Bank increased its poverty estimates by 400 million people (World Bank 2008a).
2. The World Bank also revised its gross domestic product (GDP) deflators for a number of countries, affecting growth estimates for these countries over time (World Bank 2008b).
3. ASTI's earlier global agricultural R&D investment updates only included high-income members of the Organisation for Economic Co-operation and Development (OECD), excluding a number of other high-income countries, such as Israel, Kuwait, and South Korea. Furthermore, developing countries as a group have become increasingly diverse and now include countries that have experienced prolonged periods of economic decline, those that have experienced sustainable economic growth, and many with more advanced economies. To distinguish among these different country groupings, ASTI has reclassified its global dataset into high-, middle-, and low-income country categories.
4. Since the previous global study was published in 2006, ASTI has released new quantitative information for a number of Asian and Latin American countries, and the institutional data coverage for a few large countries (such as Iran and Mexico) has increased. In addition, the OECD has released updated S&T investment data. Although these new datasets are insufficient to estimate a new global update beyond 2000, the current revision reports some of these recent regional trends.

REVISED GLOBAL AGRICULTURAL R&D INVESTMENT TRENDS

Public Investment Trends

In 2000, global public agricultural research investments totaled $23 billion in 2005 PPP dollars (that is, in inflation-adjusted terms).[2] This sum represents an increase of 47 percent over the 1981 total of $16 billion (Table 1). Although spending by the high-income countries as a whole continued to grow in absolute terms, their share of global spending decreased from 62 to 57 percent over the 1981–2000 period. In contrast, the share of spending by low-income countries increased from 9 to 11 percent and the share of middle- income countries increased from 29 to 32 percent over the same timeframe.

Spending in the Asia–Pacific region rose nearly two and a half times during the two-decade period, largely as a result of high growth China and India, leading to a rapid rise in the region's share of global spending. In contrast, the corresponding shares for Sub-Saharan Africa and Latin America and the Caribbean declined over this time.

TABLE 1. Total public agricultural research expenditures by income class and region, 1981 and 2000

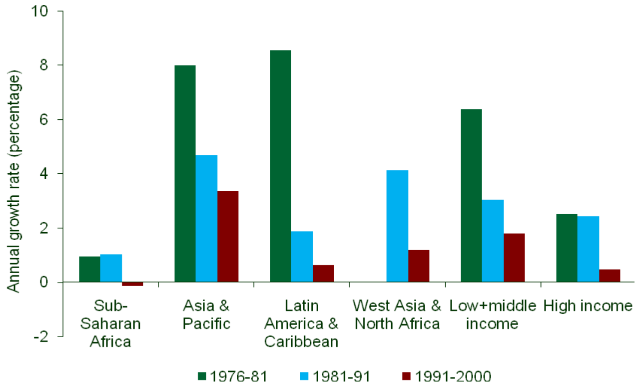
Country category	Public agricultural R&D spending 1981	2000	Regional share of global total 1981	2000
	(*million 2005 PPP dollars*)		(*percent*)	
Country grouping by income class				
Low income (46)	1,410	2,564	9	11
Middle income (62)	4,639	7,555	29	32
High income (32)	9,774	13,313	62	57
Total (140)	***15,823***	***23,432***	***100***	***100***
Low- and middle-income countries by region				
Sub-Saharan Africa (45)	1,084	1,239	7	5
China	713	1,891	5	8
India	400	1,301	3	6
Asia–Pacific (26)	1,971	4,758	12	20
Brazil	1,005	1,209	6	5
Latin America and the Caribbean (25)	2,274	2,710	14	12
West Asia and North Africa (12)	720	1,412	5	6
Subtotal (108)	*6,049*	*10,119*	*38*	*43*

Sources: Calculated by the authors based on the ASTI datasets, Pardey et al. 2006, and OECD (various years).

Notes: The number of countries included in the regional totals is shown in parentheses. These estimates exclude Eastern Europe and former Soviet Union countries. Estimation procedures and methodology are described in Pardey et al. 2006 and various ASTI regional reports available at www.asti.cgiar.org.

Growth in inflation-adjusted spending has slowed since the 1970s, when most regions experienced high growth rates (Figure 1). Overall spending in developing countries (defined as low- and middle-income countries) increased by 1.9 percent per year on average during the 1990s, which was lower than the 3.0 percent growth rate recorded a decade earlier. Annual spending growth in the Asia–Pacific region and in West Asia and North Africa remained comparatively high during the 1990s (3 percent a year). The Latin America and the Caribbean region and high-income countries as a whole experienced moderate spending growth over this time (0.3 and 0.5 percent, respectively). In contrast, total public agricultural R&D spending in Sub-Saharan Africa decreased at an annual average rate of 0.2 percent during the 1990s. And 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 (Beintema and Stads 2006).

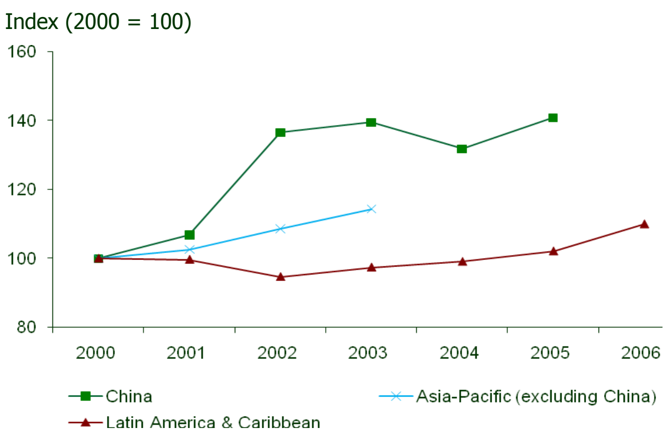
FIGURE 1. Growth rates in public agricultural research expenditures, 1981–2000



Sources: Calculated by authors based on ASTI datasets, MOST (various years), OECD (various years), and Pardey et al. (2006); 1976–81 growth rates are from Pardey and Beintema (2001).

Although data on global public agricultural R&D investments since 2000 are not yet available, more recent information has been collected for some regions (Figure 2).[3] Growth in public agricultural R&D spending continued beyond 2000 in China, with the exception of 2004 when investments contracted. Following a strong decline in the late 1990s due to the financial crisis in a number of Southern Cone countries, total spending on public agricultural R&D in Latin America and the Caribbean rebounded, reaching slightly higher levels in 2006 than those of a decade earlier.

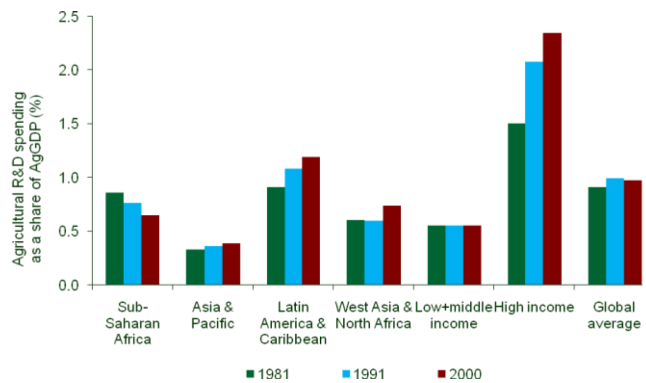
FIGURE 2. Total public agricultural research expenditures trends since 2000



Sources: Calculated by the authors based on ASTI datasets and MOST (various years). delete OECD.

Placing a country's agricultural R&D efforts in an internationally comparable context requires measures other than absolute levels of expenditures such as the intensity of investments in agricultural research. The most common research intensity indicator is total public agricultural R&D spending as a percentage of agricultural GDP. Because agricultural output grew at the same pace as total public agricultural research spending, the average intensity ratios for developing countries fluctuated slightly around 0.56 percent during 1981–2000 (Figure 3). In contrast, the average intensity for the high-income countries as a group increased considerably during this two-decade period. In 2000, high-income countries spent a combined $2.35 on public agricultural R&D for every $100 of agricultural output, whereas they spent $1.51 per $100 of output in 1981. More than half of the industrialized countries for which data are available had higher research intensity ratios in 2000 than in 1991. Most countries in the samples for the Asia–Pacific and Latin American and Caribbean regions also increased their intensity ratios (Beintema and Stads 2008; Stads and Beintema 2008). Only 6 of the 26 countries in Sub-Saharan Africa, however, reported higher intensity ratios in 2000 than in 1991 (Beintema and Stads 2006).

FIGURE 3. Intensity ratios of public agricultural research expenditures, 1981, 1991, and 2000



Sources: Calculated by the authors based on ASTI datasets, MOST (various years), OECD (various years), and Pardey et al. (2006); GDP deflators are from World Bank (2008c).

The use of intensity ratios is not always appropriate because they do not take into account the policy and institutional environment within which agricultural research occurs or the broader size and structure of a country's agricultural sector and economy. Human and capital investments have a fixed base component, regardless of the size of a country's population, especially when facilities and services are dispersed across broad areas. Furthermore, a number of countries conduct research in areas related to the agribusiness sector, whose production value is counted as manufacturing not agriculture (and hence is not included in agricultural GDP). More importantly in this context, an increase in the research intensity could mean not a higher level of investment, but rather a decrease in agricultural output—the case for a number of OECD countries during the 1990s (OECD various years).[4]

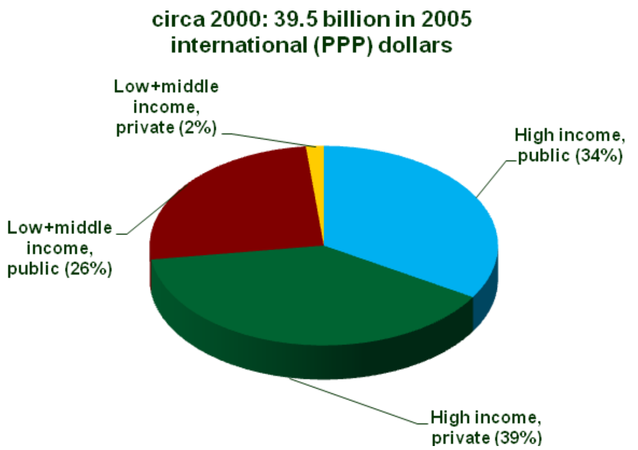
A number of countries, such as China and India, continue to have relatively low intensity ratios (Beintema and Stads 2008). Nevertheless, both of these countries have significantly increased their agricultural R&D investments over the past decade or so, such that their agricultural research systems are well equipped in terms of both infrastructure and human resources. Specific areas, however, may require further investment. Consequently, research intensity ratios need to be considered within the appropriate context of investment growth, human resource capacity, and infrastructure.

Private-Sector Investment Levels

The amount of agricultural research conducted by the private sector has grown in recent years, especially in high-income countries and more advanced developing countries. Nevertheless, the role of the private sector in the developing world is still small and is likely to remain so given weak funding incentives for private research. In addition, many private-sector activities in developing countries focus solely on the provision of input technologies or technological services for agricultural production, but most of those technologies are produced in the developed world (Beintema and Stads 2006; Pardey et al. 2006).

In 2000, of the $40 billion in total global agricultural R&D spending (in 2005 PPP dollars), the private-sector was estimated to account for 41 percent (Figure 4), the vast majority of which was performed in industrialized countries (96 percent). In contrast, only 6 percent of total investments in the developing world were derived from private firms. Private-sector involvement in agricultural research was relatively higher in the Asia–Pacific region—at 11 percent in 2000—than in other parts of the developing world (Pardey et al. 2006).

Figure 4. Total public and private spending in agricultural research expenditures



Sources: Calculated by the authors based on ASTI datasets and OECD (various years).

Spending Trends by the Consultative Group on International Agricultural Research

Agricultural research conducted at the international level is mostly undertaken by the Consultative Group on International Agricultural Research (CGIAR). Together, the CGIAR centers spent $445 million on agricultural R&D in 2006 (in 2005 US dollars). In the first two decades since the CGIAR's establishment in 1972, spending grew at relatively high annual rates. During the 1997–2000 period, however, CGIAR spending declined by 10 percent. In 2000, CGIAR spending totaled $379 million—the lowest level since the mid-1980s in real terms. Since 2000, total funding has grown, but with a continuing trend toward earmarked support for specific research projects and programs involving multiple centers and research providers outside the CGIAR. In 2006, these "restricted" funds accounted for 58 percent of total funding, compared with less than 40 percent in the early 1990s.

Although the CGIAR plays an important role in agricultural R&D for developing countries, it accounts for only a small part of total global agricultural R&D spending. In 2000, CGIAR spending as a share of total public agricultural R&D investments in developing and high-income countries was 1.6 percent; the share increases to 3.7 percent when the high-income countries are excluded. The latter figure is also lower than the 1991 equivalent of 4.9 percent.[5]

MAIN CHANGES SINCE THE PREVIOUS GLOBAL UPDATE

Revisions to PPP indexes and to the ASTI database led to a downward adjustment in calculations of total global public agricultural R&D investments by about one-tenth. As was previously mentioned, this reduction is largely the result of a downward adjustment of total spending for China and India. China's share of total global agricultural R&D spending in 2000 is now estimated to be 8 percent (down from 14 percent in 2006; Pardey et al. 2006) while India's share is now 6 percent (down from 8 percent). The PPP indexes for the United States, Japan, and other high-income countries did not undergo such major revisions. However, due to large downward PPP adjustments in many other countries as well as the reclassification of non-OECD high-income countries, the 2000 share of high-income countries combined increased to 57 percent. One of the major findings of ASTI's previous updates of trends in global public agricultural R&D spending thus no longer holds. High-income countries as a group still invest more in public agricultural R&D than the developing countries and developing countries are catching up to their high-income counterparts more slowly than was previously estimated.

WHY MEASURE INVESTMENTS IN PPP DOLLARS RATHER THAN U.S. DOLLARS?

Comparing economic data across countries is a highly complex process owing to important differences in price levels among countries. ASTI collects data on national agricultural R&D spending in local currency units, which must be converted into a common currency before comparisons can be made across countries and regions. Standard market exchange rates are the logical choice for conversions when measuring financial flows across countries; however, they are far from perfect currency converters for comparing economic data. Official exchange rates tend to understate the values of economies with relatively low price levels and overstate those with relatively high price levels. No fully satisfactory method has yet been devised to compare consumption or expenditure trends among countries.[6] At present, the preferred conversion method for calculating the relative size of economies or other economic data, such as agricultural R&D spending, is the PPP index. PPPs measure the relative purchasing power of currencies across countries. They eliminate the differences in pricing levels for a wide range of goods and services across countries and are used to convert current GDP prices of individual countries into a common currency.

The largest components of a country's agricultural R&D expenditures are staff salaries and local operating cost rather than capital investments that are traded internationally. For example, the wages of a field laborer or lab assistant at a research facility are much lower in India than in any European country; locally made office furniture in Kenya is considerably cheaper than a similar set of furniture bought in the United States. In this situation, PPP indexes offer two main advantages over market exchange rates. First, PPPs are relatively stable over time, whereas exchange rates fluctuate considerably (for example, the fluctuations in the dollar–euro rates during the past few years). Second, PPP indexes take into account nontraded goods and services; market exchange rates are influenced by traded goods and capital flows only (Callen 2007).

The International Comparisons Project (ICP), which is coordinated by the World Bank, produced PPP estimates based on benchmark survey rounds for 100 developing countries. EUROSTAT and the OECD are also partners in ICP and produced PPP estimates for 46 OECD and other countries. The PPP indexes released in February 2008 differ substantially from previous estimates for a large number of countries because of a more extensive benchmark survey round in terms of coverage and methodology. China, for example, participated in the survey for the first time. China and India's new 2005 PPP estimates are two-thirds higher than the corresponding rates in the World Bank's *2007 World Development Indicators*. For some other countries, including oil-exporting countries, PPP rates were adjusted downward (Elekdag and Lail 2008; World Bank 2008a).

Comparative Public Agricultural R&D Investment Levels

Globally, public agricultural R&D spending (excluding Eastern Europe and the former countries of the Soviet Union) totaled $18 billion in 2000 when measured in U.S. dollars using market exchange rates, whereas when measured in international dollars using PPP indexes, the total value increases to $23 billion. The total values of agricultural R&D spending in high-income countries are virtually the same regardless of which method is used because market exchange rates and PPP indexes are more similar for most developed countries (Table 2). The gaps in the results from the two conversion methods are much more significant, however, in emerging markets and developing countries owing to the aforementioned underestimation of national price levels when U.S. exchange rates are used. Consequently, total spending levels for low- and middle-income countries are half as much when measured in U.S. dollars as they are when measured in PPP dollars. In short, in relative terms, the U.S. dollar estimates overstate the high-income country share of global agricultural R&D investments, and they vastly understate the African, Asian, Latin American, and Middle Eastern shares.

Table 2. Total public agricultural R&D spending in PPP dollars versus U.S. dollars, 2000

	Public agricultural R&D spending		Regional share of global total	
Country category	**U.S. dollars**	**PPP dollars**	**U.S. dollars**	**PPP dollars**
	(*million 2005 dollars*)		(*percentage*)	
Countries by income class				
Low income (46)	932	2,564	5	11
Middle income (62)	3,525	7,555	19	32
High income (32)	13,902	13,313	76	57
Total (140)	***18,359***	***23,432***	***100***	***100***
Low- and middle-income countries by region				
Sub-Saharan Africa (45)	561	1,239	3	5
China	795	1,891	4	8
India	433	1,301	2	6
Asia-Pacific (26)	1,848	4,758	10	20
Brazil	674	1,209	4	5
Latin America and the Caribbean (25)	1,435	2,710	8	12
West Asia and North Africa (12)	613	1,412	3	6
Subtotal (108)	*4,457*	*10,119*	*24*	*43*

Sources: See Table 1.

Notes: See Table 1.

IMPLICATIONS

International organizations such as the World Bank, IMF, and Food and Agriculture Organization of the United Nations (FAO) are increasingly committed to improving the quality of and access to data. Similarly, the ASTI initiative also aims to improve the quality of and access to its datasets on agricultural R&D investment and capacity trends. Comparing economic data across countries is highly complex because of important price differences. The comparison of agricultural R&D expenditures across countries is particularly difficult, given that most of these expenditures go to salaries and local operating costs rather than to capital goods that are traded internationally. PPP indexes are the preferred measure because market exchange rates generally understate the quantity of research resources used in economies with relatively low price levels.

Due to the PPP and other revisions outlined in this brief, ASTI's estimates of global public agricultural R&D investments have been revised downward. As a result high-income countries as a group still invest more in public agricultural R&D than do developing countries as a group.

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NOTES

1. The OECD defined S&T indicators as "analytical tools (. . .) designed to answer questions about the S&T system, its internal structure, its relation with the economy and society, and the degree to which it is meeting the goals of those who manage it, work within it, or are otherwise affected by its impacts" (Tijssen and Hollanders 2006).
2. ASTI uses a procedure described by Pardey, Roseboom, and Craig (1992) that first deflates research expenditures in current local currency unites and then converts to a common currency unit using PPPs. 2005 was selected as the base year to correspond with the 2005 benchmark PPP indexes released by the World Bank.
3. ASTI has recently initiated new data collection efforts in Sub-Saharan Africa and plans to publish a new global update in early 2010.
4. ASTI is currently preparing a more in-depth report on assessing the intensity of agricultural research, which will discuss these issues in more detail.
5. The 3.7 percent is substantially lower than the 8.6 percent reported by von Braun et al. (2008) because von Braun et al. present agricultural spending data in U.S. dollars using market exchange rates.
6. Pardey, Roseboom, and Craig (1992) discuss the measurement issues related to international comparative analyses of agricultural R&D spending in more detail.

About ASTI

The Agricultural Science and Technology Indicators (ASTI) initiative compiles, processes, analyzes, and reports data on institutional developments, investments, and human resources in agricultural R&D in developing countries. The ASTI initiative is widely recognized as the most authoritative source of information on the support for and structure of agricultural R&D worldwide. The 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. To know more about the ASTI initiative, visit www.asti.cgiar.org.

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IFPRI was established in 1975. IFPRI is one of 15 agricultural research centers that receives its principal funding from governments, private foundations, and international and regional organizations, most of which are members of the Consultative Group on International Agricultural Research (www.cgiar.org).