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KEY TRENDS IN GLOBAL AGRICULTURAL RESEARCH INVESTMENT

Nienke Beintema, Alejandro Nin Pratt, and Gert-Jan Stads

This note provides an overview of investment trends in global agricultural research to the year 2016, which revises ASTI's prior global update (Beintema et al. 2012). Although data on agricultural research investments are outdated, irregular, or incomplete for some countries, this update was prompted by ASTI's new datasets for Africa and Asia, newly released data for high-income countries from the Organisation for Economic Cooperation and Development, and additional data from various other secondary sources, particularly for Latin America, China, and United States.[1]

Long-term Investment Trends by Region and Income Level

Following a decade of slow growth in the 1990s, global agricultural research spending (excluding the private for-profit sector) rose from $31 to $47 billion during 2000–2016, measured in inflation-adjusted, purchasing power parity (PPP) dollars (Figure 1).[2] Importantly, most of this growth occurred during 2000–2010, and China accounted for about half of the increase, which—combined with growth in other large middle-income countries—caused the middle-income country share to expand from 40 to 59 percent of the global total. Overall, 9 countries invested more than 1 billion dollars in agricultural research in 2016, and their combined investment represented nearly two-thirds of the global total that year. Of the 9, the 5 top-ranked countries were China ($8 billion), the United States ($5 billion), India ($4 billion), Brazil ($3 billion), and Japan ($3 billion), followed by France, Germany, Iran, and South Korea (which each invested between $1 and $2 billion). In sharp contrast, 122 of the sample of 179 countries invested less than $100 million in agricultural research in 2016, and 52 of these spent less than $10 million.

Total global spending on agricultural research grew by 2.5 percent per year on average during 2010–2016 (Figure 2). This slightly lower average yearly increase compared with the prior decade (2.9 percent during 2000–2010) stemmed from slower growth in Brazil and China, combined with negative growth in the high-income countries. Spending by high-income countries as a group represents an exception to the global growth pattern. In the 1980s, growth in yearly spending by these countries averaged 2.3 percent, falling to 1.3 percent in the 1990s, 0.7 percent during 2000–2010, and –0.8 percent during 2010–2016. The contraction was most severe in the United States, where spending fell from $5.8 billion in 2006 to $4.2 billion dollars in 2014—reflecting a shift in government priorities away from agriculture under the mistaken perception that the private sector would fill the void (Pardey and Beddow 2017). Total investment also contracted in Europe during 2010–2016 at an average rate of 1.3 percent per year. In fact, nearly half of the 40 European countries for which data are available invested less in agricultural research in 2016 than they did in 2010.

Table 1. Agricultural research spending by region and income level, 1981–2016

	2011 PPP dollars (billion)			Share (%)		
Region/country	**1981**	**2000**	**2016**	**1981**	**2000**	**2016**
Low- and middle-income countries (128)	*8.3*	*12.9*	*28.2*	*39*	*42*	*60*
Africa south of the Sahara (44)	1.3	1.6	2.3	6	5	5
Asia–Pacific (25)	2.5	5.1	15.3	12	17	33
China	0.2	1.0	7.7[a]	1	3	16
India	0.5	1.6	4.0	2	5	9
Other Asia–Pacific (23)	1.8	2.6	3.7	8	9	8
Latin America and the Caribbean (24)	2.8	3.1	4.7	13	10	10
Brazil	1.4	1.8	2.7[b]	7	6	6
Other Latin America and the Caribbean (22)	1.4	1.4	2.1	7	4	4
Central/West Asia and North Africa (22)	1.3[c]	2.3	4.5[c]	6	7	10
Europe (13)	0.4	0.6	1.3	2	2	3
High-income countries (51)	*12.8*	*18.0*	*18.6*	*61*	*58*	*40*
Asia–Pacific (7)	3.3	4.8	4.6	16	15	10
Europe (27)	4.6	6.4	7.6	22	21	16
North America (2)	4.0	5.6	5.3[d]	19	18	11[d]
Other high income (15)	0.8	1.3	1.2	4	4	3
TOTAL (179)	**21.1**	**30.9**	**46.8**	**100**	**100**	**100**

Sources: Calculated by authors from Beintema et al. (2012), updated to 2016 using data from ASTI (2020), Eurostat (2020), InSTePP (2019), OECD (2020), RICYT (2020), World Bank (2019), and a number of other secondary resources.

Notes: The private for-profit sector is excluded due to lack of available data; figures in parentheses indicate the number of countries in each category; income groups were based on the situation in 2019. Data include estimated spending for various (short) timeframes for various countries. See this page on the ASTI website for more information on data sources and estimations by country.

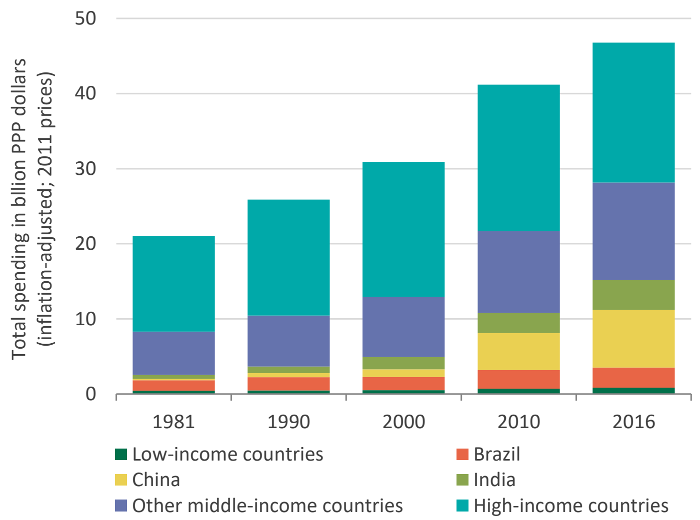
a. The InSTePP data series for China runs until 2013; spending data for the 2014–2016 period were estimated using yearly growth trends on agricultural science and technology (S&T) published in China's S&T yearbooks (NBS and MOST, various years).

b. The ASTI data series for Brazil runs until 2013; spending data for the 2014–2016 period were estimated using yearly expenditure figures for the Brazilian Agricultural Research Corporation (Embrapa 2019).

c. Spending data for Central/West Asia and North Africa for 1981–1999 and 2013–2016 periods were estimated.

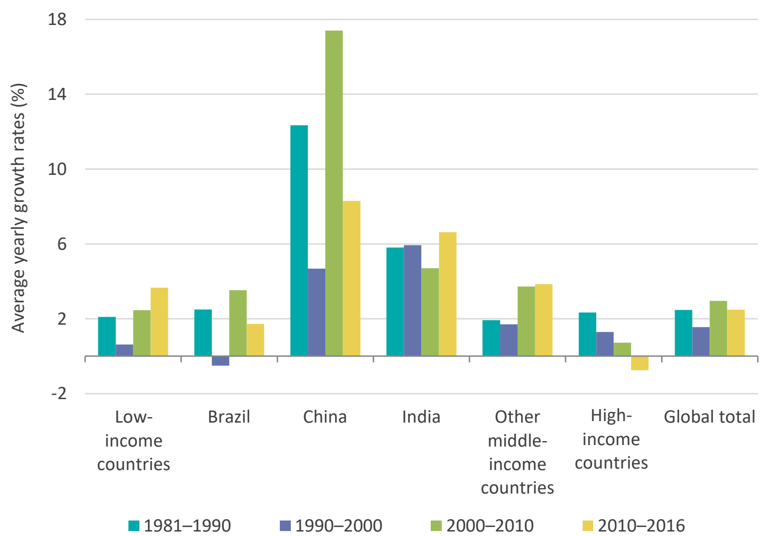
d. 2016 spending data was estimated using 2015 spending data for the United States and 2013 spending data for Canada.

Figure 1. Agricultural research spending by income group, 1981–2016



Sources and notes: See Table 1.

Figure 2. Growth in agricultural research spending by income group, 1981–2016

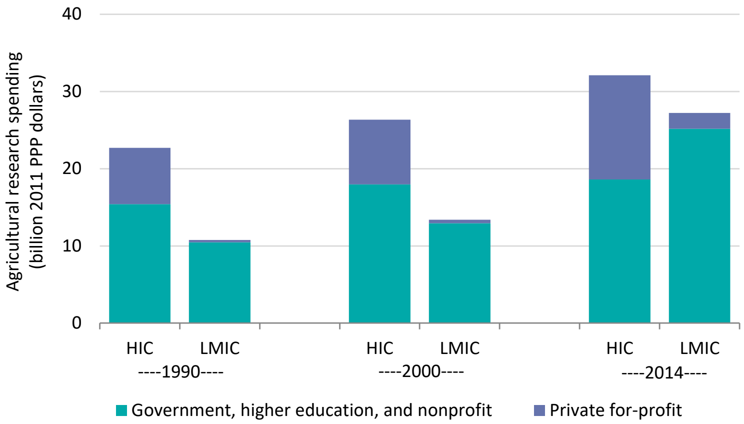


Sources and notes: See Table 1.

The Role of Private Investment

Between 1990 and 2014, global investments in agricultural research by the private-for profit sector doubled (in 2011 PPP prices) from $8 to $16 billion (Figure 3). As a result, the private sector's share of global agricultural research grew from 21 to 26 percent during this timeframe, indicating that growth in global private agricultural research investment outpaced the combined global growth of the government, higher education, and nonprofit sectors.[3] More detailed observations reveal considerable growth in private-sector spending after 2003, from around 3 percent per year during 1990–2003, to more than 7 percent per year during 2003–2014. Fuglie (2016) attributes this increased investment in part to a response to rising commodity prices during 2002–2008, which fueled farmers' willingness and ability to spend more on purchased inputs—including the latest technologies—to improve their harvests. Private companies responded by intensifying their research investment, suggesting that they expected farmers' demand for productivity-enhancing technologies to continue to rise into the future.

Figure 3. Private vs. nonprivate agricultural research spending by income group, 1990–2014



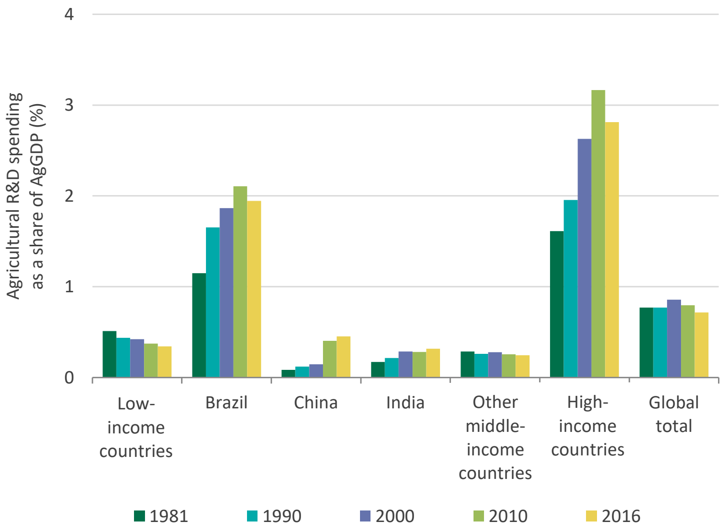
Sources: See Table 1; data for the private for-profit sector are from Fuglie (2016).
Notes: Data include estimated spending for West Asia and North Africa for 1981–1999 and various (short) timeframes for other countries. Data exclude research on food processing. HIC = high-income countries; LMIC = low- and middle-income countries.

Private research appears to be concentrated on a relatively small number of commodities. Fuglie (2016) found that, globally, maize and soybeans are the most intensively researched crops by the private sector by far, followed by fruit and vegetables, wheat, poultry, rice, pigs, cotton, oilseed, sugar crops, and aquaculture. In contrast, such commodities as cassava, yams, sweet potatoes, coffee, and cocoa—which are economically important in many low- and middle-income countries, particularly in Africa—do not receive much attention from these global performers of private agricultural research. For this reason, a crucial role remains for national government research agencies, universities, commodity boards, and CGIAR centers. And this is especially the case in areas where incentives for private research are low. Opportunities to mobilize joint public–private investment in research (prior to commercialization) still need to be exploited.

Agricultural Research Intensity and Underinvestment at the National Level

Absolute spending is not the only way to compare national and regional agricultural research investment levels. Another method of evaluating a country's agricultural research investment—and to facilitate cross-country comparisons—is to calculate its agricultural research spending relative to its agricultural gross domestic product (AgGDP). This indicator is known as the research intensity ratio (Figure 4). The intensity ratio has been the common tool for comparing spending levels over time and across countries, and has been used internationally for setting investment targets. In fact, both the United Nations and the African Union Commission have recommended that countries invest at least 1 percent of the value of their agricultural output in agricultural research. In 2016, 0.72 percent of global AgGDP was spent on agricultural research. Spending averaged 0.34 of AgGDP in low-income countries; 0.24 percent in middle-income countries other than Brazil, China, and India; and 2.81 percent in high-income countries. The average intensity ratio for developing countries as a group—and for individual developing regions—has remained fairly constant over time, indicating that growth in agricultural research spending largely followed the pattern of growth in AgGDP. In contrast, in high-income countries, for every $100 of AgGDP, agricultural research spending rose steadily from $1.61 in 1981 to $3.45 in 2009, but declined markedly thereafter to reach $2.81 in 2016. The recent decline was primarily driven by a contraction in agricultural research spending in the United States.

Figure 4. Traditional agricultural research intensity ratios by income group, 1981–2016



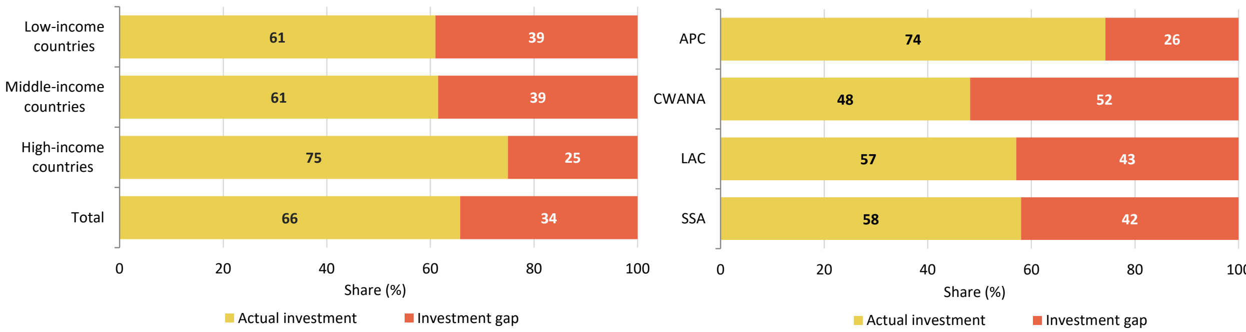
Sources and notes: See Table 1; AgGDP data are from World Bank (2019).

Agricultural research intensity ratios for most of low- and middle-income countries are well below the recommended 1 percent target, especially in the countries of the Asia–Pacific (APC) and Africa south of the Sahara (SSA). In 2016/17, only a handful of low- and middle-income countries from SSA—and none from APC—invested 1 percent or more of their agricultural output in agricultural research (Beintema 2020). In fact, about 60 percent of the 49 countries for which data were available recorded 2016/17 intensity ratios of less than 0.5 percent. Furthermore, those that had reached the 1 percent target were mostly small countries, which require higher levels of investment in human resources and capital infrastructure because, unlike larger countries or those where agriculture is less important to the national economy, they are unable to benefit from economies of scale.

Although extensively used, intensity ratios are based on the assumption that a country's investment in agricultural research should be proportional to the size of its agricultural sector. But in reality a country's capacity to invest in agricultural research depends on a range of factors, not just one. For this reason, ASTI developed a more nuanced measure to estimate a country's "attainable" level of investment that combines the size of a country's agricultural sector with three additional variables: the size of a its economy, its income level, and the availability of relevant technology spillovers from other countries. This measurement, the intensity index, is weighted according to a country's particular circumstances and comparisons with countries exhibiting similar structural characteristics.[4] Spending below this benchmark level is considered an indicator of potential underinvestment. Compared with traditional intensity ratios, the intensity index provides a very different perspective on the intensity of agricultural research investment, with such countries as Brazil, China, and India recording similar levels to those of the United States.

ASTI's intensity index can also be used to calculate the gap between a country's actual agricultural research investment and what is deemed attainable based on comparisons with countries of similar status. This, in turn, allows the investment needed to close the gap to be quantified. Based on this assessment, the global investment gap in agricultural research was estimated to be 34 percent in 2016, ranging from an average of 25 percent for high-income countries, to 39 percent for both low-income and middle-income countries (Figure 5). The underinvestment gap in APC (26 percent) was substantially lower than in Central /West Asia and North Africa (53 percent), Latin America and the Caribbean (43 percent), or SSA (42 percent), reflecting the impact and importance of the agricultural research conducted in China and India, both of which invest very close to their attainable levels.

Figure 5. Agricultural research investment gap by income level and region, 2016



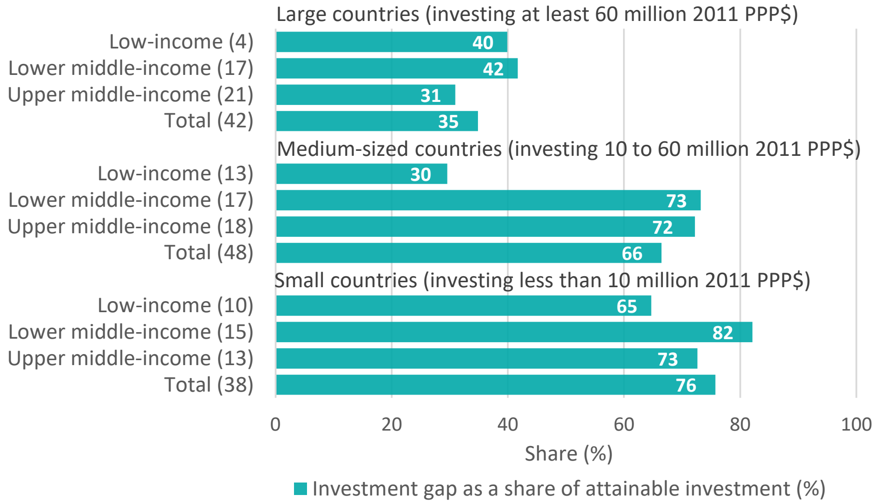
Source: Calculated by authors.

Notes: Data indicate the investment gap in terms of its share of actual 2016 investment. APC = Asia–Pacific; CWANA = Central/West Asia and North Africa; LAC = Latin America and the Caribbean; and SSA = Africa south of the Sahara.

Countries with small research systems are more likely to be constrained by their available resources, making it challenging for them to attain critical mass, and hence to achieve the intended returns to their research investment. For this reason, it is also important to assess the gap in investment based on the size of a country's agricultural research system. To do this, low- and middle-income countries were grouped according to two variables: (1) the size of their agricultural research system (in terciles of research investment, measured in millions of 2011 PPP dollars) and (2) their national income level—that is, low-income, lower middle-income, and upper middle-income (Figure 6). Results show that underinvestment is prevalent among countries with small- and medium-sized research systems (that is, those investing less than $60 million per year). The average investment gap in these countries is 76 and 66 percent, respectively, of their actual investment. The equivalent share for countries with large research systems is roughly half that (35 percent). Most countries with small and medium-sized agricultural research systems significantly underinvest in agricultural research. Chad, Gabon, Guinea, Madagascar, Myanmar, and the Republic of Congo, for example, invested only 20 percent or less of their estimated attainable levels in 2016. In contrast, countries with larger systems such as Ghana, India, and Kenya invested either at or near optimal levels.

Given the limited potential for investment in agricultural research in countries with small systems, many will require a more strategic approach, such as prioritizing the adaptation of existing knowledge and technologies to local circumstances, or collaborating with other countries to target issues of common relevance.

Figure 6. Gap between actual and attainable investment, by national investment-level and income-level grouping, 2016 (%)



Source: Calculated by authors.

Note: Figures in parentheses indicate the number of countries in each category.

Conclusion

After a decade of sluggish growth in the 1990s, global agricultural research spending grew by 50 percent during 2000–2016, mostly driven by China and other large middle-income countries. Concurrently, spending in high-income countries stalled, ending the period with negative growth, while global investments by the private-for profit sector doubled. These trends caused the middle-income country share of total global investments to increase from 40 to 58 percent during the 2000–2016 period. Analysis of the intensity of research investment, based on ASTI's intensity index, indicates that the global gap in agricultural research investment was 34 percent of the world's attainable investment in 2016, ranging from 25 percent in high-income countries to 39 in low-income countries. APC recorded the lowest investment gap (only 26 percent), which reflects the impact of China's and India's high levels of investment in their respective systems. More detailed analyses of low- and middle-income countries show that underinvestment is prevalent among countries with small and medium-sized research systems. These findings suggest that closing the investment gap will depend on sustained investment growth in large countries, such as Brazil, China, and India, and faster growth in other countries with large research systems. Countries with both small research systems and low potential to increase their investment in agricultural research will need to adopt alternative strategies—such as collaboration with countries and regions that share mutual research needs and goals—in order to acquire the knowledge and technologies they need to achieve agricultural development and growth in the coming decades.

Endnotes

1. See this page on the ASTI website for more information on data sources and estimations by country.
2. Note that all dollar values are based on 2011 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.
3. It is important to note that investment in research on food processing is not included because this type of research focuses on manufacturing and new product development, which has limited relevance for agricultural production; research conducted by input manufacturers—that is, seed, chemical, pharmaceutical, and machinery companies—is included because it involves the development of higher quality farm inputs of relevance to agriculture (Beintema et al. 2012; Fuglie 2016).

4. A major challenge in building this multifactor index was assigning appropriate weights to each of the four underlying factors in order to reflect their relative importance to each individual country. For more information, see Nin Pratt (2016).

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1201 Eye Street, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info

Nienke Beintema (n.beintema@outlook.com) is the former head of ASTI; Alejandro Nin Pratt (a.ninpratt@cgiar.org) and Gert-Jan Stads (g.stads@cgiar.org) are senior research fellow and senior program manager, respectively, within IFPRI's Environment and Production Technology Division.

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