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Benchmarking Agricultural Research Indicators Across Asia–Pacific

Kathleen Flaherty, Gert-Jan Stads, and Attaluri Srinivasacharyulu

ASTI Regional Synthesis Report • July 2013

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International Food Policy Research Institute | Washington, DC
Asia–Pacific Association of Agricultural Research Institutions | Bangkok, Thailand

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ABOUT IFPRI

The International Food Policy Research Institute (IFPRI), established in 1975, provides evidence-based policy solutions to sustainably end hunger and malnutrition and reduce poverty. The Institute conducts research, communicates results, optimizes partnerships, and builds capacity to ensure sustainable food production, promote healthy food systems, improve markets and trade, transform agriculture, build resilience, and strengthen institutions and governance. Gender is considered in all of the Institute's work. IFPRI collaborates with partners around the world, including development implementers, public institutions, the private sector, and farmers' organizations, to ensure that local, national, regional, and global food policies are based on evidence. IFPRI is a member of the CGIAR Consortium.

ABOUT ASTI

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

The Asia Pacific Association of Agricultural Research Institutions (APAARI) aims to strengthen the research capabilities of national agricultural research systems in the region and promote experience sharing among them in order to alleviate poverty, increase agricultural productivity and resource use, protect/conserve the environment and improve sustainability. The primary focus of APAARI objectives is to enhance exchange of scientific and technical knowhow and information in agricultural research for development; assist in strengthening research capability of member institutions and promote cross linkages among national, regional and international research organizations.

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Introduction

The countries that comprise Asia–Pacific exhibit enormous diversity. On the one hand the region is home to the world's only two countries with populations of more than one billion people (China and India), but on the other hand it comprises numerous Pacific Island microstates. Levels of economic development across countries are equally diverse, with low-income countries like Bangladesh, Cambodia, and Nepal producing just a fraction of the gross domestic product (GDP) of neighboring high-income countries like Australia, Japan, New Zealand, Singapore, and South Korea.

Over the past five decades agricultural development has been a major factor in improving the standard of living for millions of people across the region, particularly in China and Southeast Asia. Investment in agricultural research and development (R&D) supported significant increases in agricultural production through the implementation of research-based agricultural methods and new technologies. Agricultural productivity growth, in turn, improved rural incomes, and food and nutrition security, lifting many people out of poverty and allowing a number of countries to diversify their economies beyond agricultural production (World Bank 2007; IAASTD 2008; Fuglie, Wang, and Ball 2012).

Since 1990, the number of people in Asia–Pacific living on $1.25 per day or less has effectively been halved, from 1.5 billion to 0.8 billion as of 2010 (UN ESCAP 2012). Despite the progress, two-thirds of the world's poorest people today live in the region, mostly in India, Bangladesh, and Pakistan, and many of them in rural areas (UN ESCAP 2012). Reducing poverty further and ensuring food security in the coming decades—especially in light of the challenges of rapid population growth, food and financial crises, and climate change—will require serious investment in the agricultural sector. In particular, long-term commitment to sustained agricultural research funding is needed to ensure institutional stability, efficacy, and efficiency. To measure this commitment, quantitative data are essential for agricultural R&D stakeholders. Data facilitate the analysis of trends in agricultural research investments and capacity; the identification of gaps and neglected areas; setting of future investment priorities; and better coordination of agricultural R&D across institutes, regions, and commodities.

This report analyzes and benchmarks indicators of public agricultural R&D for Asia–Pacific. It draws largely from a set of publications based on recent datasets derived from primary surveys prepared by the Agricultural Science and Technology Indicators (ASTI) initiative of the International Food Policy Research Institute (IFPRI) and various secondary datasets. These data have been linked with historical datasets from ASTI and other sources for the region, thereby allowing a more long-term analysis of public agricultural R&D investment and capacity trends.

Public Investment Levels

Spending Trends

During 1996–2008, agricultural R&D spending in Asia–Pacific increased by 50 percent, from $8.2 billion to $12.3 billion in 2005 PPP prices (Table 1).[1] The main driving countries of this regionwide growth were China and India. China's agricultural R&D spending rose from 1.6 to 4.0 billion PPP dollars (in 2005 prices) over this period, largely as a result of government reforms that promoted innovation in agricultural science and technology (S&T) and which opened new funding opportunities. India's level of investment also increased substantially during this time due to increased government commitment to agricultural R&D. However, at 2.3 billion PPP dollars in 2008, India's agricultural R&D spending levels remained about half those of China's.

1 Evidence of growth in resources for private agricultural R&D in the region

In line with growing financial resources for public agricultural R&D, research spending by private firms has also increased in many of the low- and middle-income countries of Asia–Pacific. As with public spending, China and India lead in private agricultural research investment. In 2006, the latest year for which data were available, the private sector accounted for 16 percent of all agricultural research spending in China, at a value of 565 million PPP dollars in 2005 constant prices (Hu et al. 2011). In India, the private sector contributed one-fifth of total agricultural research expenditures in 2008/09 or 531 million PPP dollars (Pray and Nagarajan 2012). Private-sector research in China focuses primarily on issues related to livestock, whereas plant-breeding research dominates in India. Private companies in both countries conduct a significant amount of research on agricultural machinery and food processing, but these activities are categorized as manufacturing and hence are not usually included in agricultural R&D analyses. The inclusion of these categories would increase private spending on agricultural R&D to 979 million PPP dollars for China and 700 million for India (Hu et al. 2011; Pray and Nagarajan 2012).The conduct of private agricultural R&D in Bangladesh and Pakistan is minimal compared with the public sector, but it is growing (Rashid, Ali, and Gisselquist 2011; Naseem et al. 2012). Much of this research focuses on the seed industry. In Pakistan, an average of 5.5 percent of the sales of surveyed seed companies was channeled into R&D in 2009. Fertilizer research also received a significant share of investment from private firms.

Recent data on private participation in agricultural R&D in other low- and middle-income countries in the region were not available. Firms are often unwilling to share proprietary information, particularly about financial resources, making it difficult to collect private agricultural research data at the national level.

Table 1—Public agricultural R&D spending in Asia–Pacific, 1996, 2002, and 2008

INCOME GROUP/COUNTRY	TOTAL SPENDING (million 2005 PPP dollars)		
	1996	2002	2008
$ Low-income countries (4)	111	154	177
Bangladesh	83	110	131
Cambodia	na	na	17
Myanmar	7	6	na
Nepal	18	30	24
$$ Middle-income countries (22)	3,827	5,284	7,582
China	1,584	2,540	4,048
India	929	1,441	2,121
Indonesia	359	266	*379*
Lao PDR	na	12	na
Malaysia	280	436	381
Pakistan	201	147	188
Papua New Guinea	28	21	17
Philippines	129	139	*133*
Sri Lanka	40	44	39
Thailand	*236*	*181*	*171*
Vietnam	23	55	86
$$$ High-income countries (6)	4,222	4,427	4,511
Australia	666	794	590
Japan	2,746	3,004	3,112
Korea, Rep. of	673	501	685
New Zealand	136	127	123
Asia–Pacific Total (32)	8,160	9,865	12,270

Sources: Beintema et al. 2012, ASTI 2012, Eurostat 2012, OECD 2012, and various country-level secondary resources (see data sources at http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf and notes below).

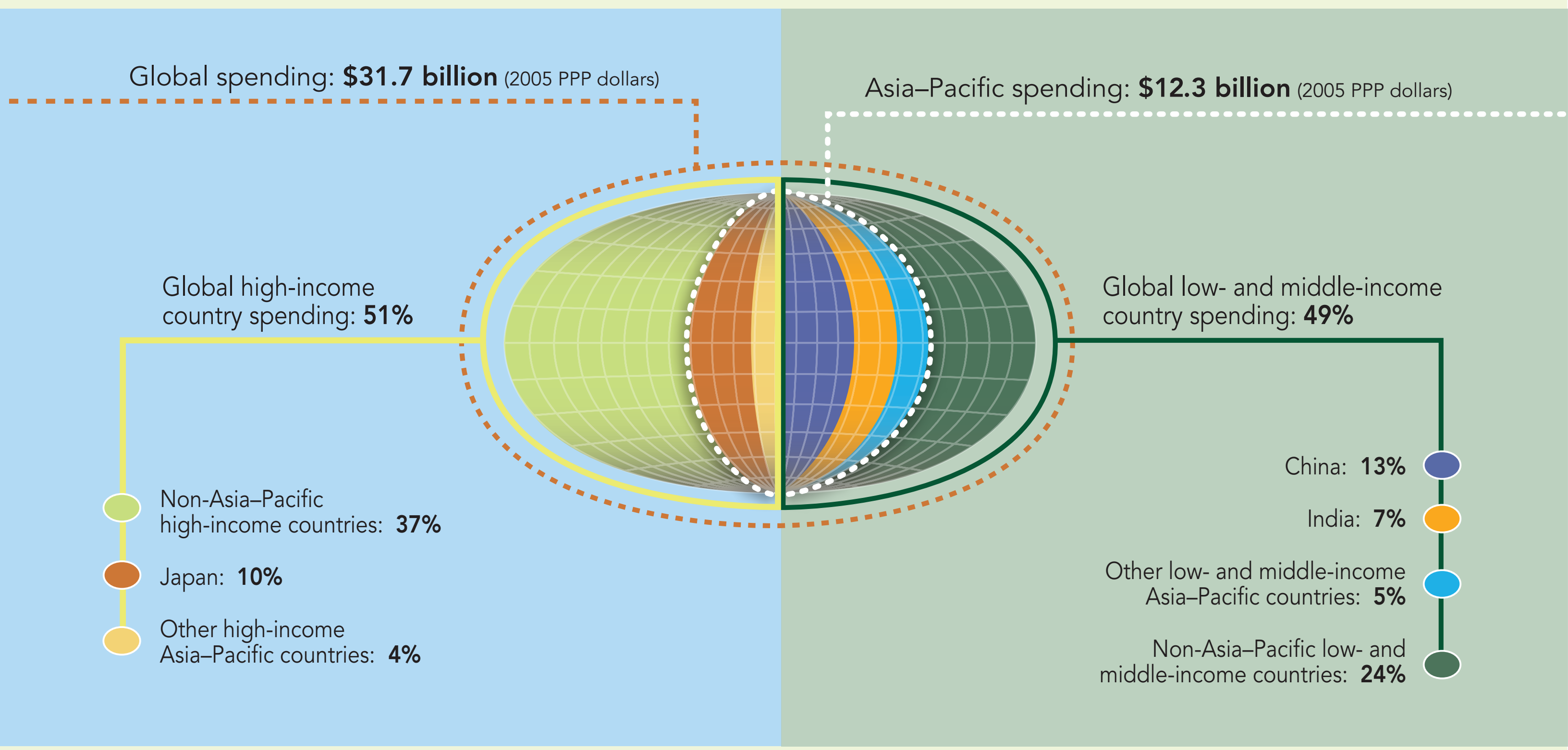
Notes: Countries have been categorized by income group using the World Bank's 2012 classifications. Data for North Korea were not available, so it was excluded from income-group aggregates. Data in italics were estimated, using various country-level secondary data sources; na indicates that data were not available. The low-income-country total includes estimates for countries with incomplete time-series data. The middle-income-country total includes 11 small middle-income countries for which data were estimated based on their share of total regional agricultural output (Bhutan, Fiji, Kiribati, Maldives, Micronesia, Mongolia, Palau, Samoa, Solomon Islands, Tonga, and Vanuatu); this total also includes estimates for countries with incomplete time-series data. The high-income-country total includes two small high-income countries for which data were estimated based on their share of total regional agricultural output (Brunei and Singapore).

Various other low- and middle-income countries in the region reported increased expenditure levels. Agricultural R&D spending in Cambodia and Vietnam quadrupled between 1996 and 2008, and Bangladesh and Malaysia also reported significant increases. The region's high-income countries maintained relatively high levels of public agricultural R&D spending; however, yearly growth in expenditure levels among high-income countries was significantly lower compared with the region's low- and middle-income countries. As a result, the high-income countries' overall share of regional public agricultural R&D spending dropped from 52 percent in 1996 to 37 percent in 2008. In 2008, China outspent the rest of the region, accounting for one-third of total regional expenditures, followed by Japan (25 percent) and India (17 percent).

Following a decade of slowing growth in the 1990s, global public spending on agricultural R&D increased from 2005 PPP $26.1 billion in 2000 to $31.7 billion in 2008 (Beintema et al. 2012). Asia–Pacific contributes significantly to global agricultural R&D. In 2008, the region as a whole accounted for 39 percent of global public agricultural R&D spending, up from a quarter in the mid-1990s (Figure 1). China and India together accounted for roughly half of the $5.6 billion global growth during 2000–08. Furthermore, spending growth in the region's low- and middle-income countries has outpaced all other regions since the 1980s.

Governments in both China and India have strongly supported public agricultural R&D, acknowledging its important role in driving agricultural growth. China's public agricultural research spending, which nearly

Figure 1—Global public agricultural R&D spending, 2008



Sources: See Table 1.

Notes: Coverage includes 179 countries categorized by income group using the World Bank's 2012 classifications. Regional totals were aggregated from national totals. 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*.

2 China and India compared with Brazil

As large, middle-income countries with emergent economies, China and India are frequently compared with Brazil. Furthermore, the Brazil Agricultural Research Corporation (Embrapa) is often presented as a model for agricultural research agencies endeavoring to emulate Brazil's success in raising agricultural productivity. Although China and India outpace Brazil's agricultural R&D spending in absolute terms, Brazil's agricultural intensity ratio, as described below, is much higher: 1.52 percent in 2008 (Beintema, Avila, and Fachini 2010) compared with 0.50 for China and 0.40 for India the same year. Despite the significant growth in agricultural research investment in recent years, China and India still spend considerably less, compared to the size of their agricultural output, than Brazil.

doubled during 2000–2008, is estimated to have increased by another 50 percent (or an additional $2 billion dollars in 2005 prices) during 2009–2010. The Indian government has also increased its funding to agricultural research since the late-1990s, and has accelerated investment growth since 2008 (Beintema et al. 2012).

Public Spending Intensity Ratios

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 in an international context—is to calculate its agricultural research spending relative to agricultural GDP (AgGDP). This indicator is commonly known as the research "intensity ratio." In 2008, for every 100 dollars of AgGDP, Asia–Pacific countries spent 0.63 dollars on public agricultural R&D on average (Table 2). Intensity ratios across the region's low- and middle-income countries are considerably lower than ratios for the four high-income countries. Despite rapid growth in agricultural R&D spending in recent years, Cambodia and Vietnam continue to have extremely low intensity ratios. Both countries invested less than 0.20 percent of their AgGDP in agricultural R&D in 2008. Despite similar, if not even greater growth, China's and India's intensity ratios remained relatively low, at 0.50 and 0.40 percent, respectively. In contrast, Malaysia, a country nearing high-income status, recorded a comparatively high ratio of 1.05 percent.

It should be noted that although intensity ratios are a good comparative indicator of R&D investment levels, they fail to take into consideration the policy context and institutional environment of a country's agricultural R&D system or the broader size and structure of a country's agricultural sector and economy. For example, small countries need more research investments relative to agricultural output because, unlike the larger countries, they cannot benefit from economies of scale. Equally, countries with greater agricultural diversity or more complex agroecological conditions can also have more complex research needs requiring higher funding levels.

Despite the limitations of intensity ratios, they do reveal that many countries in Asia–Pacific are underinvesting in agricultural R&D. Cambodia, Nepal, Pakistan, and Vietnam all invest less than 0.30 percent of their AgGDP in agricultural R&D, which is clearly insufficient considering the numerous emerging challenges these countries face, including population growth, climate change, and environmental degradation, all of which will necessitate increased food production across the region in the coming decades. Being aware of these challenges, some national governments have set ambitious agricultural R&D investment targets (India and Nepal, for example, aim to invest 1 percent of their

Table 2—Agricultural R&D intensity ratios in Asia–Pacific, 1996–2008

INCOME GROUP/COUNTRY	PUBLIC AGRICULTURAL R&D SPENDING AS A SHARE OF AgGDP		
	1996	2002	2008
$ Low-income-country average	0.23	0.25	0.21
Bangladesh	0.33	0.36	0.34
Cambodia	na	na	0.16
Myanmar	0.06	0.03	na
Nepal	0.25	0.35	0.27
$$ Middle-income country average	0.34	0.43	0.43
China	0.33	0.46	0.50
India	0.25	0.38	0.40
Indonesia	0.37	0.28	*0.31*
Lao PDR	na	0.30	na
Malaysia	1.15	1.92	1.05
Pakistan	0.36	0.24	0.25
Papua New Guinea	0.77	0.54	0.39
Philippines	0.34	0.48	*0.33*
Sri Lanka	0.43	0.53	0.34
Thailand	*0.69*	*0.51*	*0.32*
Vietnam	0.09	0.17	0.17
$$$ High-income country average	3.23	3.48	4.13
Australia	4.06	3.35	3.56
Japan	4.03	4.79	5.46
Korea, Rep. of	1.66	1.45	2.30
New Zealand	2.57	2.15	2.22
Asia–Pacific average	0.62	0.70	0.63

Source: Compiled by authors based on ASTI 2012, Eurostat 2012, OECD 2012, and various country-level secondary resources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

Notes: See Table 1.

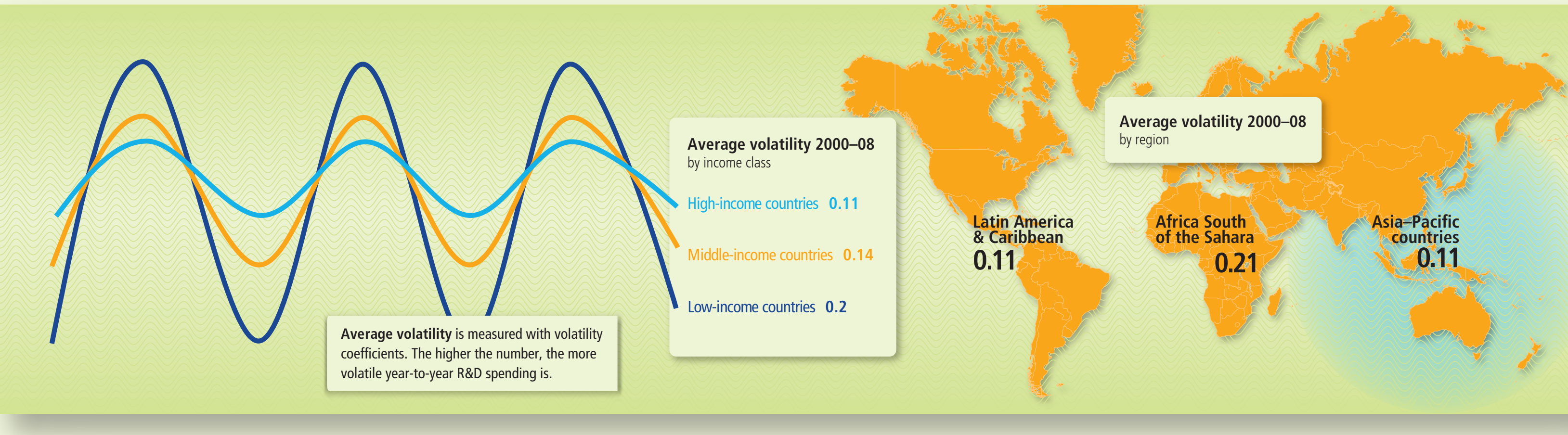
AgGDP on agricultural R&D). Although such investment targets can be useful to mobilize resources for agricultural R&D, simply doubling, tripling, or quadrupling investments should not be misconstrued as the end goal. The real goals are to ensure that R&D agencies have the necessary human, financial, operating, and infrastructural resources to effectively and efficiently develop, adapt, and disseminate S&T innovations within an appropriate enabling public policy environment in order to maximize their impact on the agriculture sector, on rural and economic development more generally, and ultimately on poverty and hunger.

Public Spending Volatility

The inherent time lag between the inception of a study and the adoption of a new technology or crop variety demands that financial resources are both 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 year to year. Volatility coefficients, which quantify shifts in agricultural R&D spending levels, are useful tools for assessing funding volatility across countries and regions, and for providing insights into the main drivers of funding shocks. ASTI calculated volatility coefficients for 85 countries worldwide, based on complete time-series data on agricultural R&D expenditures for the 2001–2008 period (Figure 2). 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 yearly fluctuations in spending levels have high volatility coefficients. A value of 0 indicates no volatility, whereas values above 0.20 indicate relatively high volatility (Stads 2011).[2]

Volatility coefficients were available for 10 countries in Asia–Pacific. The mean volatility for these 10 countries was 0.11, which is comparable to the mean volatility for Latin America and the Caribbean, as well as the average for developed countries (Beintema et al. 2012). A closer look at volatility levels by country reveals some interesting cross-country variation. Of particular note, volatility levels were higher than the regional average in Nepal (0.22), Vietnam (0.17), and Bangladesh (0.14) (Table 3). Although volatility is driven by a variety of factors across countries, detailed funding data reveal that the main driver of volatility in developing countries worldwide is the short-term, project-oriented nature of donor and development bank funding (Stads 2011). Low-income (and lower middle-income) countries are more dependent on funding from donors and development banks, and this type of funding has shown considerably greater volatility in the past decade compared with government and other R&D funding sources. The relatively high volatility coefficient

Figure 2. Agricultural R&D spending volatility across income groups and regions, 2000–2008



Source: Compiled by authors based on ASTI 2012.

Note: Volatility coefficients quantify volatility in agricultural R&D spending by applying the standard deviation formula to average one-year logarithmic growth of agricultural R&D spending over a certain period. For more information, see Stads (2011).

Table 3—Volatility coefficients of yearly agricultural R&D spending growth, 2001–2008

COUNTRY	VOLATILITY COEFFICIENT
Bangladesh	0.14
Cambodia	0.12
China	0.09
India	0.06
Malaysia	0.12
Nepal	0.22
Pakistan	0.10
Papua New Guinea	0.10
Sri Lanka	0.11
Vietnam	0.17

Source: Compiled by authors based on ASTI 2012.

Note: Volatility coefficients quantify volatility in agricultural R&D spending by applying the standard deviation formula to average one-year logarithmic growth of agricultural R&D spending over a certain period. For more information, see Stads (2011).

for Nepal, for example, is the result of the World Bank–financed Agricultural Research and Extension Project (AREP), a four-year multi-million dollar project that prompted severe declines in agricultural research spending levels when it ended in 2002.

Funding Sources

National governments provide the majority of funding for agricultural research in Asia–Pacific. Donor funding and development bank loans have also provided crucial support in many of these countries, particularly in support of operating costs and capital investments. Sales of goods and services and commodity levy revenue also supplement the revenues of many of the main agricultural research agencies across the countries.

In China, government grants contributed 86 percent of funding for public agricultural research agencies in 2006–07. In contrast, donors provided 70 percent of 2010 funding to Lao PDR's main government agency, the National Agriculture and Forestry Research Institute (NAFRI). At the Cambodian Agricultural Research and Development Institute (CARDI) and the National Agricultural Research Institute (NARI) in Papua New Guinea, the 2010 shares for donor funding were 44 and 29 percent, respectively. Bangladesh, India, Nepal, Pakistan, and Sri Lanka, while primarily government funded, have also received significant support for research through large-scale World Bank funded projects. Malaysia's commodity-focused research agencies, the Malaysian Palm Oil Board and the Malaysian Rubber Board, are examples of how research funding can be generated through commodity levies. Revenue from cesses (taxes) on the export of oil palm and rubber varies from year to year, but accounted for 78 and 27 percent of total funding of these two agencies in 2010, respectively.

Human Resources

Capacity Trends and Qualification Levels

In recent decades, most countries in Asia–Pacific have made considerable progress in building their agricultural R&D capacity, both in terms of scientist numbers and in terms of qualification levels. Employing 43,200 full-time equivalent (FTE) researchers in 2008, China has the largest agricultural research system both regionally and globally (Table 4). India employed 11,379 FTE researchers in 2008, fewer than in the 1990s and early 2000s due to reduced involvement in agricultural R&D by the country's state agricultural universities. Medium-sized countries, employing between 1,000 and 4,000 FTE researchers, include Bangladesh, Malaysia, Pakistan, and Vietnam.

Table 4—Public agricultural researchers and ratio to farmers for selected countries and years

COUNTRY	TOTAL RESEARCHERS			Agricultural researchers per million farmers (economically active population)
	1996	2002	2008	2008
	(full-time equivalents)			
Bangladesh	1,825	1,840	2,072	64
Cambodia	na	na	329	68
China	na	na	43,200	86
India	12,961	12,989	11,379	43
Lao PDR (NAFRI only)	na	92	145	na
Malaysia	1,052	1,142	1,538	922
Nepal	357	433	398	35
Pakistan	3,398	3,451	3,328	142
Papua New Guinea (NARI only)	na	37	70	na
Sri Lanka	511	543	652	164
Vietnam	1,960	2,716	3,514	121

Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*. Data on economically active agricultural population are from FAO 2012).

Notes: na indicates that data were not available. The National Agriculture and Forestry Research Institute (NAFRI) and the National Agricultural Research Institute (NARI) are the main government agricultural research agencies in Lao PDR and Papua New Guinea, respectively. In 2003, NAFRI accounted for 83 percent of Lao PDR's agricultural researchers; in 2002, NARI accounted for 30 percent of Papua New Guinea's agricultural researchers. Data on agricultural researchers employed in these countries other than at these two agencies were not available.

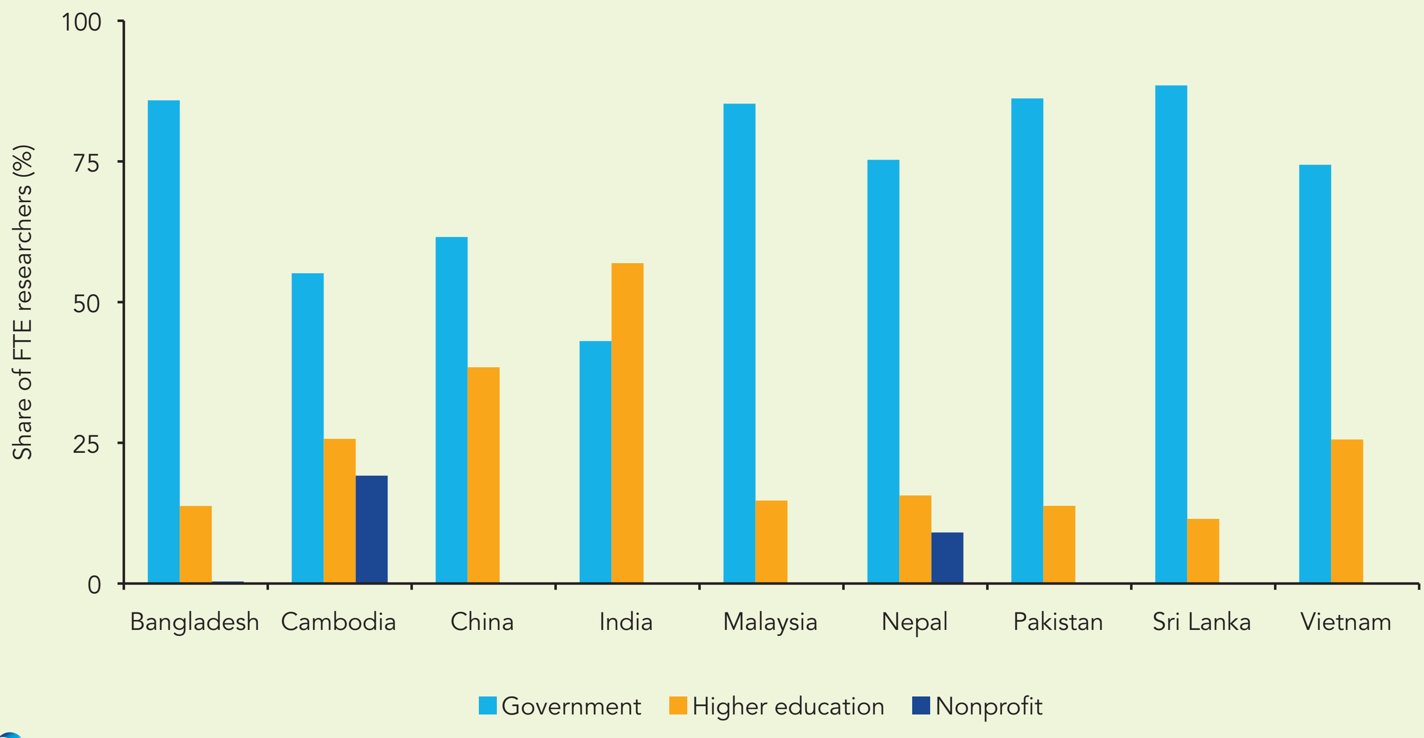
Cambodia, Nepal, and Sri Lanka all employed fewer than 1,000 FTE agricultural researchers each.

A comparison of the ratio of FTE researchers to the economically active agricultural population provides a useful cross-country comparison. Despite the large number of agricultural researchers in India, the country employs relatively fewer researchers per million farmers than most countries in the region. In 2008, India employed 42 agricultural researchers per million farmers (Table 4). In contrast, Pakistan, Sri Lanka, and Vietnam all recorded ratios of over 100. Malaysia's ratio of nearly 1,000 in 2008 reflects high research capacity and few farmers (1.7 million in 2008). It is important to note that these ratios do not take into account the qualification levels of the scientists, nor farm size (smallholder subsistence farmers versus large-scale plantation owners).

Agricultural researchers in Asia–Pacific are primarily employed in the government sector (Figure 3). In 2008, researchers employed in higher education agencies accounted for 38 percent of all agricultural researchers employed in the public sector, whereas the nonprofit sector accounted for less than 0.5 percent of all researchers. India was the only country in the region with more university-based researchers than government researchers despite declining capacity at the country's State Agricultural Universities in recent years. A number of nonprofit agencies, mostly nongovernmental organizations, operate in Cambodia and Nepal; these agencies accounted for 9 and 19 percent of the total number of agricultural researchers in those countries, respectively.

The qualification levels of agricultural research staff play an important role in determining the quality of

Figure 3—Institutional distribution of public agricultural research staff, selected countries, 2008



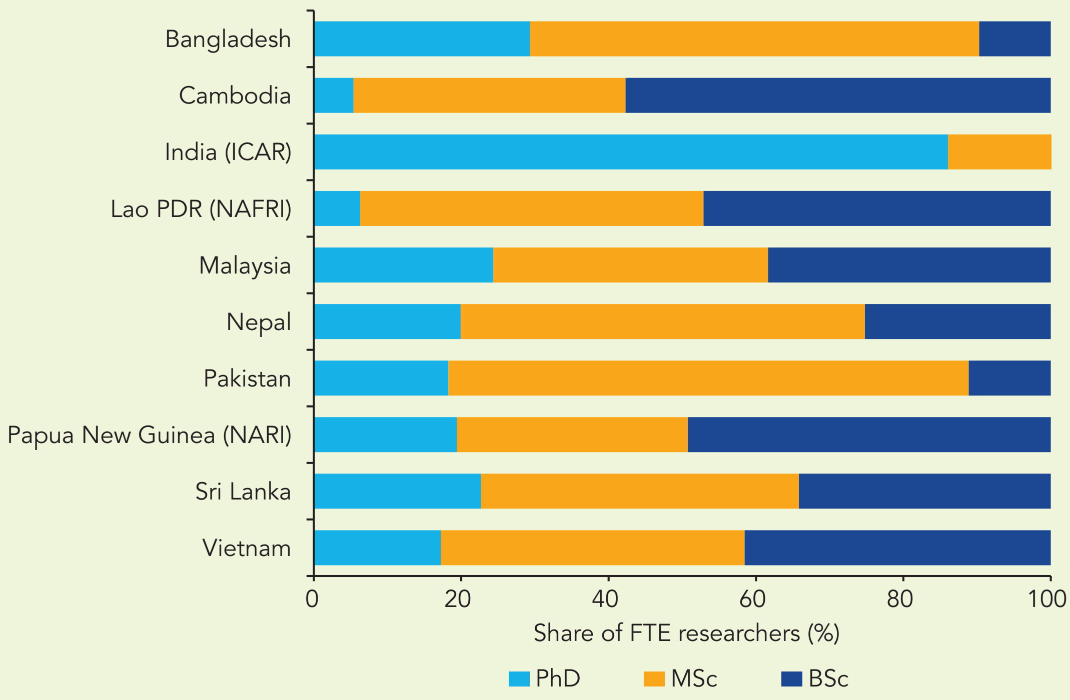
Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

research outputs, and degree qualifications vary widely by country (Figure 4). The share of researchers qualified to the PhD level at the Indian Council of Agricultural Research (ICAR), India's main agricultural research body, is especially high (86 percent). Generally, technical support staff at ICAR are highly qualified as well, often holding MSc degrees and sometimes even PhD degrees. In contrast, based on available data, most other countries in the region employ significantly lower shares of PhD-qualified researchers. In China, detailed data on researcher qualifications were not available, but of the total number of government researchers and support staff employed in 2009, 12 percent held PhD degrees, 29 percent held MSc degrees, and 59 percent held BSc degrees.

Generally speaking, the shares of researchers with postgraduate (MSc and PhD) degrees were higher in South Asian countries than in Southeast Asian countries. In Bangladesh, Nepal, and Pakistan researchers with MSc degrees comprise more than half of all research staff. Levels of staff with postgraduate degrees were particularly low in Cambodia, Lao PDR, and Vietnam. Cambodia and Lao PDR lack a critical mass of PhD-qualified scientists. Of the agricultural researchers employed in Cambodia and at NAFRI in Lao PDR, only 5 and 6 percent, respectively, held PhD degrees in 2008. The history of political and economic isolation of these countries has limited training opportunities of scientists abroad. Moreover, lack of foreign language skills by many researchers in these countries—a prerequisite for studying abroad—still presents an impediment.

Although time-series data on degree levels were available for most sample countries, the benchmark

Figure 4—Qualification levels of agricultural research staff, selected countries, 2009/2010



Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

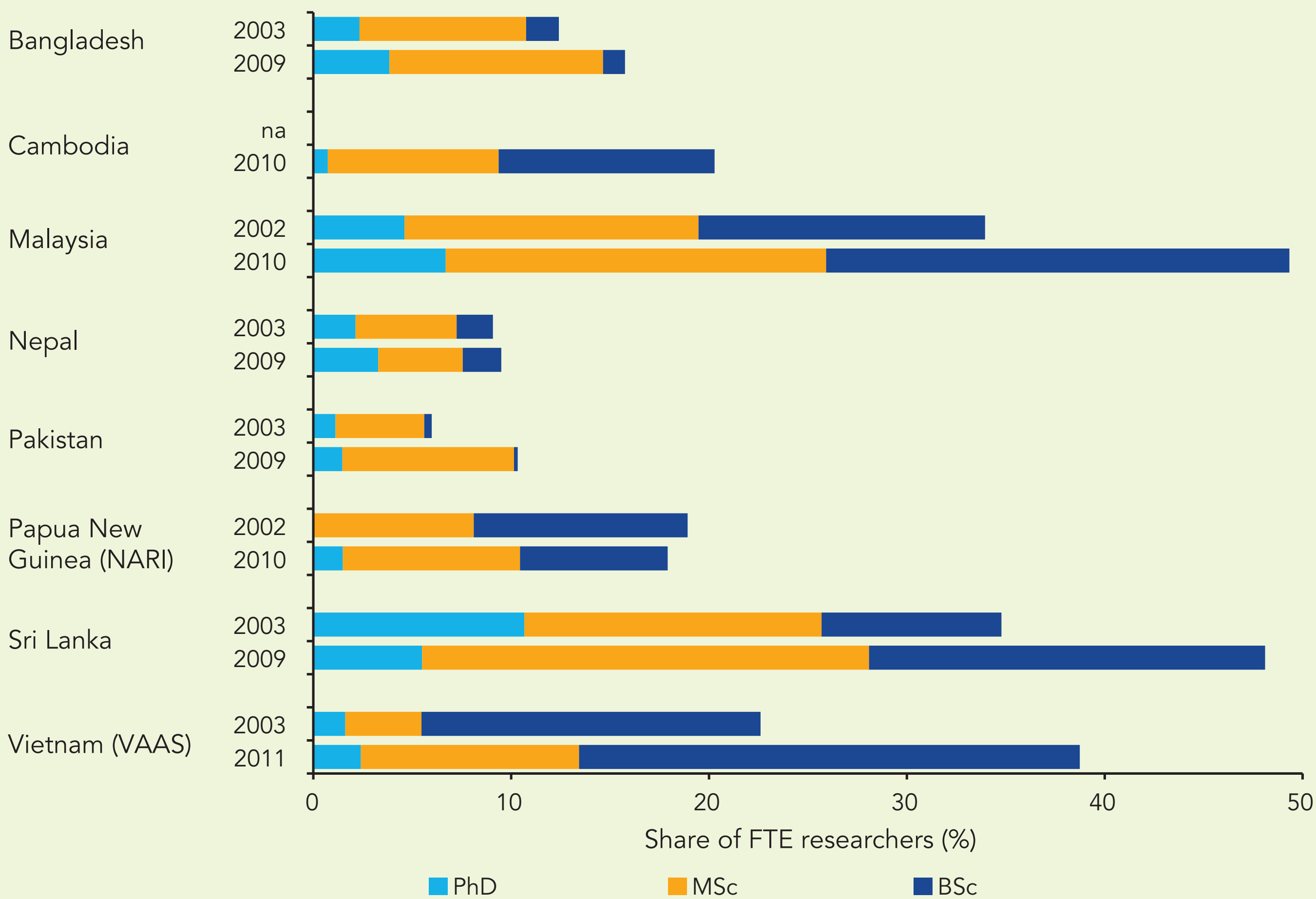
Notes: The Indian Council of Agricultural Research (ICAR), the National Agriculture and Forestry Research Institute (NAFRI), and the National Agricultural Research Institute (NARI) are the main government agricultural research agencies in India, Lao PDR, and Papua New Guinea, respectively. In 2009, ICAR accounted for 34 percent of India's agricultural researchers; in 2003, NAFRI accounted for 83 percent of Lao PDR's researchers; and in 2002, NARI accounted for 30 percent of Papua New Guinea's researchers. Data on degree qualifications of agricultural researchers employed in these countries outside these agencies were not available. Data were also not available for China. Data for Bangladesh, India, Nepal, Pakistan, and Sri Lanka are for 2009; data for Cambodia, Lao PDR, Malaysia, Papua New Guinea, and Vietnam are for 2010.

years varied, making it difficult to compare developments in researcher qualifications over time. Most of the countries for which time-series were available, however, reported improvements in the average qualification levels of research staff over the past decade, although changes were not as dramatic as those reported in the 1990s to the 2000s.

Female Participation

Employment of female agricultural researchers is very low across the region, with the exception of Malaysia, Myanmar, the Philippines, and Sri Lanka. Close to or more than half the agricultural researchers in those countries are female, generally reflecting greater gender equality in the provision of education. In contrast, only 10 percent of agricultural researchers employed in Nepal and Pakistan in 2009 were female (Figure 5).

Figure 5—Distribution of female research staff by degree qualification, selected countries and years

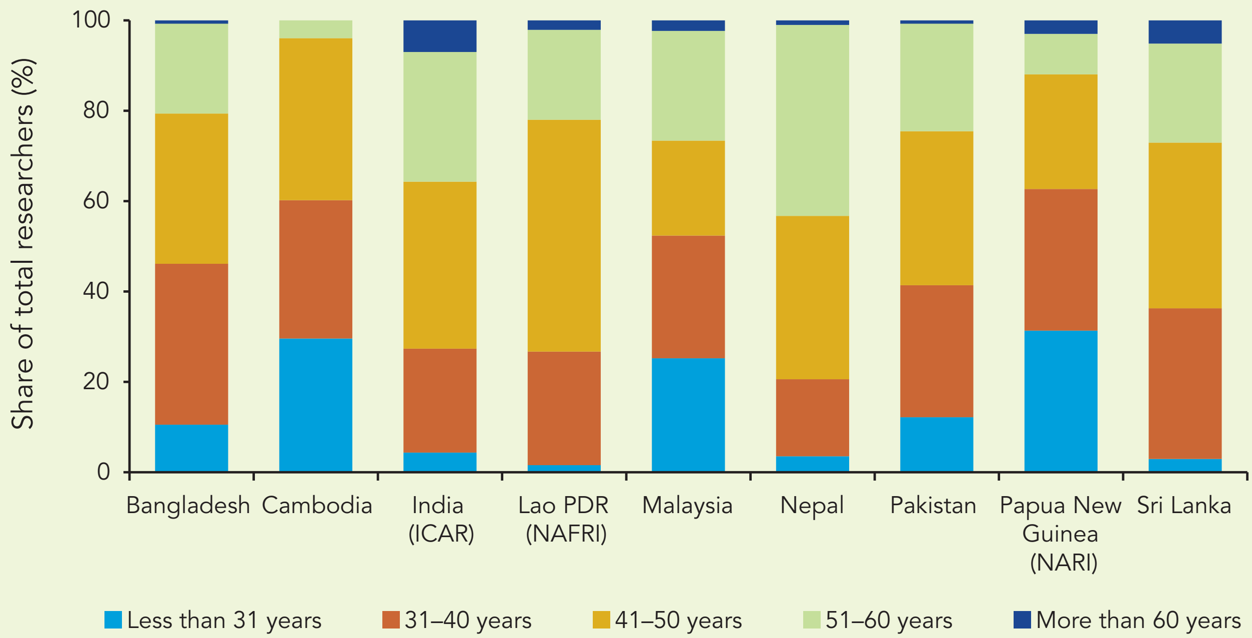


Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

Notes: na indicates that data were not available. The National Agricultural Research Institute (NARI) and the Vietnam Academy of Agricultural Sciences (VAAS) are the main government agricultural research agencies in Papua New Guinea and Vietnam, respectively. In 2002, NARI accounted for 30 percent of Papua New Guinea's researchers and expenditures; in 2010, VAAS accounted for 34 percent of Vietnam's agricultural researchers and 31 percent of expenditures. Data on female agricultural researchers employed within these countries other than at NARI and VAAS were not available. Based on availability, data for Malaysia include government agencies only.

Figure 6—Age distribution of agricultural research staff, selected countries, 2009/2010

6a. Age distribution of all agricultural research staff



Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

Notes: The Indian Council of Agricultural Research (ICAR), the National Agriculture and Forestry Research Institute (NAFRI), and the National Agricultural Research Institute (NARI) are the main government agricultural research agencies in India, Lao PDR, and Papua New Guinea, respectively. In 2009, ICAR accounted for 34 percent of India's agricultural researchers; in 2003, NAFRI accounted for 83 percent of Lao PDR's researchers; and in 2002, NARI accounted for 30 percent of Papua New Guinea's researchers. Data on degree qualifications of agricultural researchers employed in these countries outside these agencies were not available. Data on age distribution by degree qualification were not available for Sri Lanka. Data for Bangladesh, India, Nepal, Pakistan, and Sri Lanka are for 2009; data for Cambodia, Lao PDR, Malaysia, and Papua New Guinea are for 2010.

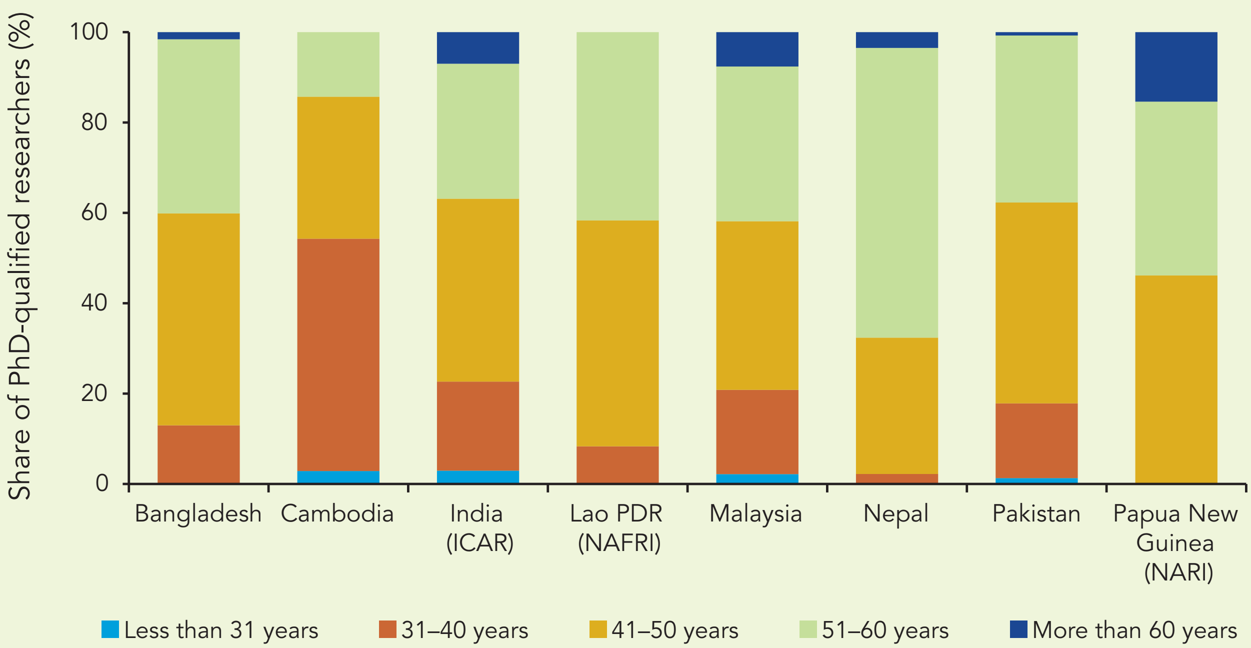
Most of the female researchers throughout the region are qualified to the BSc level, with the exception of Bangladesh and Pakistan, where an MSc degree is generally the minimum qualification required to be employed as a researcher. In China, data on the qualification levels of female researchers were not available; however, in 2009 about one-third of all agricultural researchers and support staff were female. In Indonesia, data indicate that one-quarter of researchers employed in 2003 (the most recent data available) were female. Recent data were also unavailable for Lao PDR, but as of 2003 women represented 22 percent of all research staff. Shares of female researchers have increased in most countries since the turn of the millennium.

Age Distribution

Data on research staff by age bracket provide an indicator both of current capacity and potential future capacity needs. On the one hand, a disproportionately high number of older, well-qualified researchers—as is the case in Nepal—suggests the potential for capacity to weaken as these more experienced staff retire (Figure 6). At the

Figure 6—Age distribution of agricultural research staff, selected countries, 2009/2010 *(continued)*

6b. Age distribution of PhD-qualified agricultural research staff



Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

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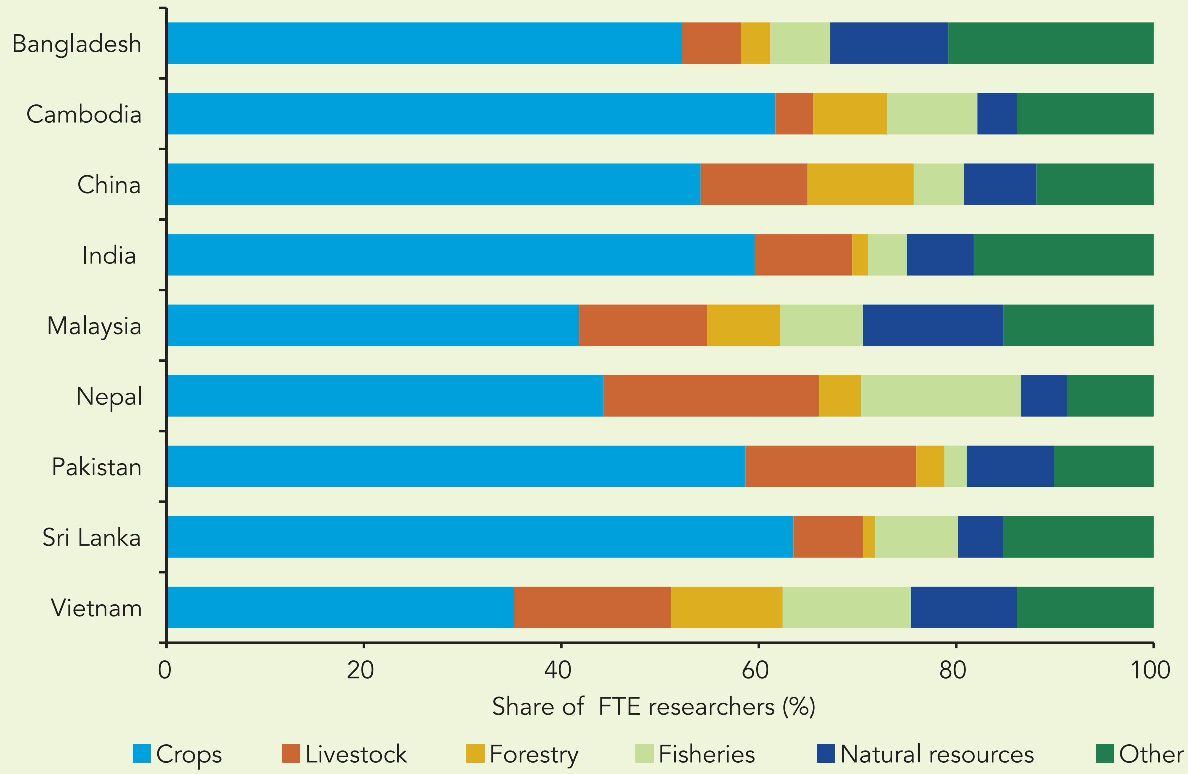
other end of the spectrum, numerous agencies employ a disproportionately high number of young, inexperienced researchers. In Cambodia and Papua New Guinea's NARI, 60 percent of agricultural scientists are in their 20s and 30s. Interestingly, the solution in both cases is prioritizing the training and mentoring of junior scientists.

Research Focus

The allocation of resources among various lines of research is a significant policy decision, so detailed information was collected on the allocation of FTE researchers across commodity areas. Half the researchers in the sample countries focused on crop research, 12 percent

Figure 7—Research focus by major commodity area, selected countries, 2008/2009/2010



Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

Notes: Data for China are for 2008; data for Bangladesh, India, Nepal, Pakistan, and Sri Lanka are for 2009; and data for Cambodia, Malaysia, and Vietnam are for 2010.

focused on livestock research, 9 percent focused on issues related to natural resources, 6 percent focused on fishery-related issues, and 4 percent focused on issues related to forestry (Figure 7). Other areas of research included postharvest issues, agricultural engineering, and socioeconomics, among others. These averages mask important cross-country differences. In Vietnam, for example, only 35 percent of scientists focused on crop research, compared with more than 60 percent of FTE researchers in Cambodia and Sri Lanka. Similarly, livestock and fisheries research played a relatively more important role in Nepal than in most other countries.

Across Asia, rice is the most widely researched crop. In each of the sample countries, rice accounted for 10–20 percent of crop scientists, with the exception of Cambodia, where it was the focus of 54 percent of FTE researchers, and Sri Lanka, where it was the focus of 5 percent of FTE researchers (Table 5). Fruit and vegetables were also highly researched crops across the region. In Malaysia the predominant crop under research was oil palm, the country's primary export crop. Wheat was also a common focus of research in South Asia, particularly in Pakistan where it was the focus of 22 percent of the country's crop scientists.

Table 5—Research focus of crop scientists by major crop item for selected countries, 2009/2010

COUNTRY	MAJOR CROP ITEMS
Bangladesh	Rice (19%), fruit (12%), vegetables (9%), potatoes (6%), sugarcane (6%), and wheat (6%)
Cambodia	Rice (54%) and vegetables (20%)
India	Rice (15%), fruit (9%), vegetables (6%), and wheat (6%)
Malaysia	Oil palm (34%), fruit (20%), rice (12%), and vegetables (9%)
Nepal	Vegetables (20%), rice (19%), wheat (12%), maize (11%), and fruit (9%)
Pakistan	Wheat (22%), rice (12%), cotton (10%), sugarcane (7%), fruit (7%), vegetables (6%), and maize (5%)
Sri Lanka	Vegetables (15%), fruit (12%), tea (11%), coconut palm (10%), and rice (5%)
Vietnam	Rice (13%), vegetables (11%), fruit (10%), corn (9%), and barley (7%)

Source: Compiled by authors based on country-level ASTI survey data and several secondary sources (see individual ASTI Country Notes available at *www.asti.cgiar.org* and data sources at *http://asti.cgiar.org/pdf/CountrySourcesEstimations.pdf*).

Notes: Major crop items are defined as those that form the focus of at least 5 percent of a country's crop researchers. Data for Bangladesh, India, Nepal, Pakistan, and Sri Lanka are for 2009; data for Cambodia, Malaysia, and Vietnam are for 2010.

Conclusion

New quantitative evidence presented in this report demonstrates that total public agricultural R&D spending in Asia–Pacific increased by 50 percent, from $8.2 billion in 1996 to $12.3 billion in 2008 (in 2005 PPP prices). Most of this growth was driven by the region's low- and middle-income countries, whereas growth in the region's high-income countries stagnated. In fact, growth in public agricultural R&D spending in the region's low- and middle-income countries has outpaced growth in all other developing regions around the world since the 1980s. As a result, the region has increasingly raised the profile of its contribution to global agricultural R&D. In 2008, $0.40 of every dollar spent on public agricultural R&D worldwide targeted Asia–Pacific countries.

Aside from increased spending, most low- and middle-income countries in the region have also made considerable progress in building human resource capacity in agricultural R&D. With a few exceptions, the number of scientists employed in most countries across the region has increased, and in all the sample countries scientists' qualification levels have improved since the 1990s. This development is notable given the widespread challenges that these agencies face, including attracting and maintaining a pool of well-qualified research staff, and dealing with disproportionate numbers of either aging, senior staff, or junior, inexperienced staff. Some countries with a history of political isolation (notably Cambodia, Lao PDR, and Vietnam) still have very low numbers of PhD-qualified staff, forming a significant impediment to advancing the quality of research. Nonetheless, these countries have wisely invested heavily in staff recruitment and training in recent years.

Despite these positive developments, agricultural R&D spending as a share of agricultural output in Asia–Pacific is lagging behind other regions of the developing world. In 2008, of the 13 low- and middle-income countries for which detailed spending data were available, Malaysia was the only country investing more than 1 percent of its agricultural GDP in agricultural research. China and India spent 0.50 and 0.40 percent, respectively, and levels in most other countries were lower still. Even though intensity ratios do not take into account the policy and institutional environment within which agricultural research takes place or the broader size and structure of a country's agricultural sector and economy, these low ratios are a clear sign of underinvestment in agricultural R&D by many of the region's low- and middle-income countries. If Asia–Pacific is to meet its agricultural, broader economic, and emerging challenges, including rapid population growth, climate change, environmental degradation, and food price volatility, levels of investment in agricultural R&D need to increase. In addition, such investments will need to be better managed, timed, and targeted to ensure maximum impact on productivity growth and poverty reduction. Increased diversification of funding sources will also be necessary. The private sector, for example, is still an untapped resource in many of the region's countries. Supporting policy reforms offer further potential to ensure that the benefits of agricultural R&D translate into results.

Asia–Pacific countries are highly diverse, as reflected in their national agricultural research systems. Nevertheless, cross-country and regional linkages are another important strategy for leveraging limited resources and reducing wasteful duplication of R&D effort. To improve the relevance, effectiveness, and efficiency of research outputs, stronger linkages are also needed between the performers of agricultural research and its end users. It goes without saying that good governance is key to promoting the effectiveness and efficiency of research and ultimately to realizing the potential of agricultural innovation.

Notes

1. 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. For more information on ASTI's methodology and data collection procedures see *www.asti.cgiar.org/methodology*.

2. In order to measure the degree of volatility in yearly agricultural R&D spending levels across countries, a commonly used method of calculating price volatility in finance and output volatility in macroeconomics was applied to ASTI's agricultural R&D spending data. The so-called volatility coefficient quantifies volatility in agricultural R&D spending by applying the standard deviation formula to average one-year logarithmic growth of agricultural R&D spending over a certain period (Durlauf, Johnson, and Temple 2008). Growth in agricultural R&D spending (g_s) can be expressed as follows:

   $$g_s = \ln\left(\frac{s_t}{s_{t-1}}\right) \qquad s=1,\ldots, N,$$

   where *s* is agricultural R&D spending (in constant prices), and *t* represents the year. Subsequently, the volatility coefficient (V) of agricultural R&D expenditures can be calculated by taking the standard deviation of growth in yearly agricultural R&D spending, that is,

   $$V = \sqrt{\frac{1}{N}\sum_{s=1}^{N}(g_s - \mu)^2}, \text{ where } \mu = \frac{1}{N}\sum_{s=1}^{N} g_s.$$

   For more details on methodology, see Stads (2011).

References

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

Beintema, N. M., F. Avila, and C. Fachini. 2010. *Brazil: New Developments in the Organization and Funding of Research*. ASTI Country Note. Washington, DC, and Brasilia: International Food Policy Research Institute and Brazilian Agricultural Research Corporation.

Beintema, N. M., G. J. Stads, K. Fuglie, and P. Heisey. 2012. *ASTI Global Assessment of Agricultural R&D Spending: Developing Countries Accelerate Investment*. Washington, DC, and Rome: International Food Policy Research Institute and Global Forum on Agricultural Research.

Durlauf, S. N., Johnson, J. A., and Temple, P. R. W. 2005. "Growth Econometrics." In Agion, P., & Durlauf, S. N. (Eds), *Handbook of Economic Growth*. Vol. 1a. Amsterdam: Elsevier.

Eurostat. 2012. Statistics. http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database (accessed April 20, 2012).

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

Fuglie, K. O., S. L. Wang, and V. E. Ball, eds. 2012. *Productivity Growth in Agriculture: An International Perspective*. Oxfordshire, UK: CAB International.

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.

IAASTD (International Assessment of Agricultural Knowledge, Science and Technology for Development). 2008. *Synthesis Report*. Washington, DC: Island Press.

Naseem, A., L. Nagarajan, M. Mudasser and F. Qureshi. 2012. *Private Agricultural Research and Innovation in Pakistan*. Montreal; Washington, DC; and New Brunswick, NJ: McGill University, International Food Policy Research Institute, and Rutgers University.

OECD (Organisation for Economic Co-operation and Development). 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).

Pray, C., and L. Nagarajan. 2012. *Innovation and Research by Private Agribusiness in India*. IFPRI Discussion Paper No. 1181. Washington, D.C. International Food Policy Research Institute.

Rashid, R., M. Ali, and D. Gisselquist. 2011. *Private Innovation and R&D in Bangladesh Agriculture: Description, Impact, and Policy Options*. Washington, D.C. and New Brunswick, NJ: International Food Policy Research Institute and Rutgers University.

Stads, G. J. 2011. "Africa's Agricultural R&D Funding Rollercoaster: An Analysis of the Elements of Funding Volatility." Agricultural R&D: Investing in Africa's Future—Analyzing Trends, Challenges, and Opportunities Conference Working Paper 2. Washington, DC, and Accra: International Food Policy Research Institute and Forum for Agricultural Research in Africa.

UN ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2012. *Statistical Yearbook for Asia and the Pacific*. Bangkok.

World Bank. 2007. *World Development Report 2008*. Washington, DC.

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

Further Reading: ASTI Synthesis Reports and Country Notes on the Asia–Pacific

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.

Flaherty, K., and R. A. Dardak. 2013. *Malaysia: Recent Developments in Public Agricultural Research*. ASTI Country Note. Washington, DC: International Food Policy Research Institute.

Flaherty, K., and E. Sotheary. 2013. *Cambodia: Agricultural R&D Indicators.* ASTI Factsheet. Washington, DC and Phnom Penh: International Food Policy Research Institute and Cambodian Agricultural Research and Development Institute, forthcoming.

Flaherty, K., M. Sharif, and D. J. Spielman. 2012. *Pakistan: Recent Developments in Agricultural Research*. ASTI Country Note. Washington, DC, and Islamabad: International Food Policy Research Institute and Pakistan Agricultural Research Council.

Girihagama, P. H. P. C., M. A. Rahija, and G. J. Stads. 2012. *Sri Lanka: Recent Developments in Public Agricultural Research*. ASTI Country Note. Washington, DC: International Food Policy Research Institute.

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

Rahija, M. A., S. M. M. Hossain, M. M. Rahman, and G. J. Stads. 2012. *Bangladesh: Recent Developments in Public Agricultural Research*. ASTI Country Note. Washington, DC, and Dhaka: International Food Policy Research Institute and Bangladesh Agricultural Research Council.

Rahija, M. A., H. K. Shrestha, G. J. Stads, and R. B. Bhujel. 2011. *Nepal: Recent Developments in Public Agricultural Research*. ASTI Country Note. Washington, DC, and Kathmandu: International Food Policy Research Institute and Nepal Agricultural Research Council.

Stads, G. J., and H. B. Huy. 2013. *Vietnam: Agricultural R&D Indicators.* ASTI Factsheet. Washington, DC and Hanoi: International Food Policy Research Institute and Vietnam Academy of Agricultural Sciences, forthcoming.

Stads, G. J., and M. A. Rahija. 2012. *Public Agricultural R&D in South Asia: Greater Government Commitment, Yet Underinvestment Persists.* ASTI Synthesis Report. Washington, DC: International Food Policy Research Institute.

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