Agricultural Science & Technology Indicators

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty
Supported by the CGIAR

ASARECA
Transforming Agriculture for Improved Livelihoods

A BENCHMARK OF AGRICULTURAL RESEARCH INVESTMENT AND CAPACITY TRENDS ACROSS ASARECA COUNTRIES

Nienke Beintema

Note • June 2011

ABSTRACT

Total investments in public agricultural research and development (R&D) in the ASARECA countries (excluding DR Congo) increased substantially from about $330 million in the late 1990s to close to $500 million in 2008 (in 2005 PPP prices). This average was larger than the growth for Sub-Saharan Africa (SSA) as a whole during the same period, but growth was not even across countries or over time. Since the turn of the millennium, public research spending growth was particularly high for Burundi, Sudan, Tanzania, and Uganda. Except for Burundi, for which growth was the result of civil unrest during the 1990s, the increase in spending was the result of increased government commitments toward (agricultural) research. With the exception of Sudan, the main agricultural research agencies in the ASARECA countries continue to be highly dependent on donor contributions and development bank loans. In contrast, R&D investments in public agricultural R&D in Ethiopia and Eritrea decreased during 2001-08, after a decade of high positive growth. This was the result of high dependence on volatile donor funding for these two countries.

Growth in agricultural research staffing varied less across countries compared with total spending. But despite this growth, average qualification levels have deteriorated slightly in a number of ASARECA countries. With roughly one third trained to the BSc level, researchers in Eritrea, Ethiopia, and Rwanda are among the least highly qualified in SSA. Other countries, such as Kenya, Madagascar, Sudan, and Tanzania, have an aging researcher pool, which are mostly the result of recruitment freezes and increasing staff retention. Most of the new hires are young and have often only BSc degrees and limited training opportunities.

Despite increased investments, addressing the financial and human resource challenges that agricultural R&D face, governments and donors will need to step up their commitments to agricultural R&D and ensure that these are stable. Furthermore, these increased and stable investments in agricultural R&D will need to be coupled by an expansion in investments in agricultural higher education. Without these, countries will be unable to provide the quantity and quality of human resource capacity needed for agricultural R&D to contribute to improved African agricultural productivity.

INTRODUCTION

Extensive empirical evidence demonstrates that agricultural research and development (R&D) investments have greatly contributed to economic growth, agricultural development, and poverty reduction in developing regions over the past five decades (World Bank 2007a; IAASTD 2008). Given important challenges, such as rapid population growth, climate change adaptation, water scarcity, and the volatility of prices in global markets, policymakers are increasingly recognizing that greater agricultural R&D investments are essential to increasing agricultural productivity in Sub-Saharan Africa (SSA).

The 2003 Maputo Declaration directed African Union (AU) member countries to increase agricultural investments to at least 10 percent of their national budgets. To gauge progress toward this target, the Comprehensive Africa Agriculture Development Programme (CAADP), under the AU's New Partnership for Africa's Development (NEPAD), agreed to monitor agricultural expenditures, setting a 6 percent yearly target for growth in agricultural gross domestic product (AgGDP) in countries where agriculture plays a dominant economic role. One of CAADP's four foundational pillars focuses on increasing investments in agricultural research, extension, education, and training as a means of promoting growth in agricultural productivity (NEPAD–CAADP 2010). Moreover, NEPAD's African Ministerial Council on Science and Technology established and adopted a Consolidated Plan of Action for developing regional science and technology (S&T). This plan calls for substantial increases in national R&D budgets, with each country taking concrete measures to allocate at least 1 percent of its gross domestic product (GDP) to R&D (NEPAD 2006).

In order to measure, monitor, and benchmark the inputs, outputs, and performance of agricultural S&T systems at the national and regional levels and to assess progress toward the successful implementation of CAADP and AMCOST targets related to S&T, quantitative data are essential. S&T indicators are an indispensable tool when assessing the contribution of agricultural S&T to agricultural growth and, more generally, to economic growth. They assist research managers and policymakers in formulating policy and making decisions about strategic planning, priority setting, monitoring, and evaluation.

Box 1—Measuring agricultural R&D resources

The concept of purchasing power parity (PPP) prices

Comparing R&D data is a highly complex process due to important differences in price levels across countries. The largest components of a country's agricultural R&D expenditures are staff salaries and local operating costs rather than internationally-traded capital investments. For example, the wages of a field laborer or laboratory assistant at a research facility are much lower in Kenya than in any European country; locally made office furniture in Ethiopia is considerably cheaper than a similar set of furniture in the United States.

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. 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 purchasing power parity (PPP) index. PPPs measure the relative purchasing power of currencies across countries by eliminating national differences in pricing levels for a wide range of goods and services. They are also used to convert current GDP prices in individual countries to a common currency. In addition, PPPs are relatively stable over time, whereas exchange rates fluctuate considerably (for example, the recent fluctuations in the US dollar–Euro rates).

The concept of full-time equivalent (FTE) researchers

ASTI bases its calculations of human resource and financial data on full-time equivalent (FTE) staffing which take into account the proportion of time researchers spend on R&D activities. University staff members, for example, spend the bulk of their time on non-research-related activities, such as teaching, administration, and student supervision, which need to be excluded from research-related resource calculations. As a result, four faculty members estimated to spend 25 percent of their time on research would individually represent 0.25 FTEs and collectively be counted as 1 FTE.

Sources: Beintema and Stads (2008, 2011b forthcoming) and ASTI's website (www.asti.cgiar.org/methodology).

They also provide information to governments and others involved in the public debate on the state of agricultural S&T at national, regional, and international levels.

This brief assesses trends in investments and human resource capacity in public agricultural R&D in 9 of the 10 member countries of the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA): Burundi, Ethiopia, Eritrea, Kenya, Madagascar, Rwanda, Sudan, Tanzania, and Uganda; data for the Democratic Republic of Congo were unavailable.[1] The analysis draws from a set of country notes prepared by the Agricultural Science and Technology Indicators (ASTI) initiative of the International Food Policy Research Institute (IFPRI) and national partners, using comprehensive datasets derived from primary surveys conducted during 2009–10.[2] These datasets have been linked with investment and human resources data that were collected previously.[3] This brief focuses on benchmarking of the various ASTI indicators across ASARECA countries and complement a series of in-depth country notes published during 2010-11 and a major synthesis report for SSA (Beintema and Stads 2011a).

LONGTERM INVESTMENT AND CAPACITY TRENDS

After a decade of stagnation spanning the 1990s, SSA saw growth of more than 20 percent in investments and human resource capacity in public agricultural R&D during 2001–08. Most of this growth, however, occurred in only a handful of countries and was largely the result of increased government commitments to augment incommensurately low salary levels and to rehabilitate neglected infrastructure, often after years of underinvestment. In contrast, many countries face fundamental capacity and investment challenges. For some, national investment levels have fallen so low as to leave them dangerously dependent on often volatile, external funding sources (Beintema and Stads 2011a).

These overall regional trends also apply to the ASARECA countries, most of which have less severe capacity and investment challenges than their counterparts in other parts of SSA (specifically West Africa). Absolute levels of public agricultural R&D spending and staffing varied considerably across these countries (Table 1). In 2008, Kenya, Uganda, Tanzania, and Ethiopia invested $171 million, $88 million, $77 million, and $69 million, respectively, on agricultural R&D; Burundi and Eritrea spent $9 million and $3 million. All investments were measured in inflation-adjusted purchasing power parity (PPP) dollars (see Box 1 for an explanation of PPPs). The 2008 distribution of research staff by country follows a similar pattern, with Ethiopia, Kenya, and Sudan each employing more than 1,000 full-time equivalent (FTE) researchers, and Burundi and Rwanda each employing slightly more than 100 FTEs (see Box 1 for an explanation of FTEs). The nine ASARECA countries combined spent about $500 million 2005 PPP dollars on public agricultural R&D and employed close to 5,000 FTE researchers, accounting

Table 1—Public agricultural R&D spending and staffing, 1991-2008

1A. R&D spending

Country	Total 2005 PPP dollars (million)				Annual growth rate (%)		
	1991–95	1996–2000	2001–05	2008	1991–96	1996–2001	2001–08
Burundi	16	4	6	10	–33.0	3.2	12.1
Eritrea	na	11	5	3	na	–4.8	–12.4
Ethiopia	30	43	91	69	10.9	16.5	–4.5
Kenya	165	139	134	171	6.6	1.9	3.3
Madagascar	19	15	10	12	–7.9	–14.5	4.3
Rwanda	na	na	na	18	na	na	na
Sudan	52	29	43	51	–21.4	2.8	8.2
Tanzania	na	38	41	77	–3.6	7.0	10.7
Uganda	na	35	62	88	5.0	4.4	9.2
Subtotal (9)	342	327	408	499	–0.43	4.0	3.6
SSA total	**1,258**	**1,247**	**1,487**	**1,727**	**–1.3**	**3.6**	**2.4**

1B. R&D staffing

Country	Total number of researchers (FTE)				Annual growth rate (%)		
	1991–95	1996–2000	2001–05	2008	1991–96	1996–2001	2001–08
Burundi	130	61	69	98	–22.4	2.6	5.1
Eritrea	na	69	90	122	na	10.7	6.6
Ethiopia	425	610	1,028	1,318	8.7	10.3	6.0
Kenya	970	915	925	1,011	–1.0	-1.3	1.5
Madagascar	189	204	209	212	2.9	1.0	0.3
Rwanda	na	na	na	104	na	na	na
Sudan	539	678	913	1,020	4.4	5.1	3.6
Tanzania	526	523	639	674	–1.1	2.8	1.4
Uganda	238	257	240	299	1.4	0.0	3.4
Subtotal (9)	3,099	3,396	4,207	4,859	1.2	3.4	3.3
SSA total	**9,001**	**9,369**	**10,404**	**12,102**	**1.2**	**1.2**	**2.8**

Sources: Compiled by author based on country-level ASTI survey data, several secondary resources, and Beintema and Stads 2011a. (For more information, see individual ASTI Country Notes available at www.asti.cgiar.org.)

Notes: Calculations are based on five-year averages, with the exception of 2008. See individual ASTI Country Notes for agency and coverage. The subtotal for the nine ASARECA countries include estimates for Rwanda for 1991-2004 (spending and staffing), Tanzania for 1991-95 (spending), and Uganda for 1991-94 (spending).

for 29 percent of total SSA spending and 40 percent of total SSA research capacity. The difference in shares indicates that on average, ASARECA countries have lower spending levels per researcher than the remainder of SSA.

Considerable differences were reported not only in absolute investment levels among the ASARECA countries but also—and more importantly—in the magnitude of growth over time. Overall, the 2001-08 growth rates of the ASARECA countries were substantially higher than the average growth rate of 2.4 percent for SSA as a whole. In the same period, Eritrea and Ethiopia experienced negative yearly growth in public agricultural spending of -12.4 and -4.5 percent per year, respectively. This followed a decade of particularly high positive growth in agricultural spending for both countries (32.7 for Eritrea and 11.0 percent for Ethiopia), which is indicative of high dependency on unstable flows of donor funding and development bank loans to both countries' agricultural R&D sector. In contrast, the other six ASARECA countries excluding Rwanda where data were not available had moderate to high positive yearly growth rates. Investment growth was particularly high for Burundi, Sudan, Tanzania, and Uganda.

Growth in agricultural research staffing varied less across countries compared with total spending. It is noteworthy that, despite strong losses in spending levels in Eritrea and Ethiopia throughout this period, researcher numbers increased by 6.6 and 6.0 percent per year, respectively, which was substantially higher than the annual growth rates in most other ASARECA countries. In Ethiopia, this growth was driven by the development of the regional agricultural research institutes (RARIs) and the higher education sector. Research capacity in Burundi also increased substantially during 2001-08, which was the result of a rehabilitation of the country's research capacity following years of civil unrest, particularly during the early 1990s. During 2001-08, research staffing increased or remained fairly constant for the other five countries excluding Rwanda.

Recent key trends by country

Each country has experienced different capacity and spending trends since the turn of the millennium, which was also evident in the variation across the annual growth rates presented in the previous section:

Burundi. This is one of the smaller countries with only a few agencies involved in agricultural research. After 1993, investments in agricultural research plummeted to very low levels in response to the civil war; all expatriates and many national researchers holding postgraduate degrees left the country. Since the turn of the millennium, spending and capacity levels increased as a result of the rehabilitation of the country's research infrastructure (Stads and Ndimurirwo 2011).

Eritrea. Overall agricultural R&D expenditures in Eritrea contracted by more than 80 percent during 1998–2008 following severe cuts in donor funding, which nonetheless remains the country's most important funding source. In contrast, agricultural research staffing levels nearly tripled during the same period. Despite this growth, Eritrea continues to have one of Africa's least qualified agricultural scientist pools (Rahija, Fesha, and Stads 2010).

Ethiopia. Agricultural research spending doubled between 1993 and 2000 and again between 2000 and 2001 following increased government and donor and development bank loans. By 2008, however, expenditures at the main agricultural research agency, the Ethiopian Institute of Agricultural Research (EIAR), had reverted to 2000 levels. Agricultural research staffing at the RARIs and higher education agencies grew significantly during 2000–08; by 2008, the combined capacity of the seven RARIs was higher than that of EIAR in terms of staffing levels, but not in terms of postgraduate qualifications (Flaherty, Kelemework, and Kelemu 2010).

Kenya. Public agricultural R&D in Kenya is well funded and staffed compared with many other SSA countries. Yearly agricultural R&D investments to the Kenya Agricultural Research Institute (KARI)variedduring 2000–08, reflecting fluctuations in funding from donors and development banks, and, to a lesser extent, the national government. Following a period of decline in the late 1990s, the number of agricultural researchers increased as a combined result of the relaxation of a government recruitment freeze and the merger of the Kenya Trypanosomiasis Research Institute (KETRI) and the Kenya Veterinary Vaccines Production Unit (KEVEVAPI) with KARI (Flaherty et al. 2010b).

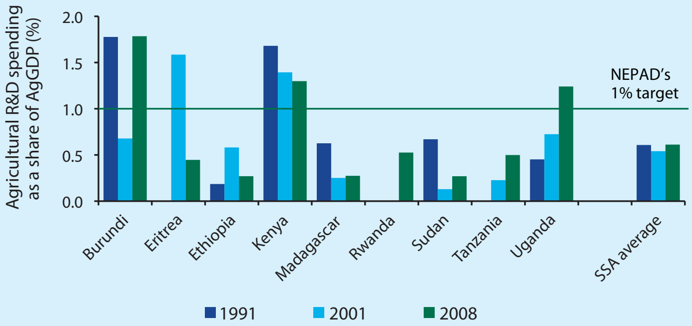
Madagascar. The completion of a large World Bank–funded project in 1999 prompted a sudden decline in Madagascar's overall agricultural R&D expenditures. Spending levels have recovered in recent years as a result of in-kind technical support from France. Despite important institute-level shifts, Madagascar's national agricultural research capacity has remained relatively unchanged during 2001-08 (Stads and Randriamanamisa 2010).

Rwanda. The total number of agricultural researchers, in terms of FTEs, has grown slightly in Rwanda since 2005, the first year for which data were available. As a result of the civil war in the 1990s, Rwanda's agricultural research staff is relatively younger and less well-qualified compared with other countries in the region. Agricultural research investments spending has remained relatively steady from 2005-09 (Flaherty and Munyengabe 2011).

Sudan. During the 1990s, agricultural R&D spending in Sudan declined rapidly due to general neglect of the agricultural sector in favor of large-scale oil production. This trend was reversed more recently with increased national government support for agricultural development, enabling greater R&D investment and hence recovery of lost ground. Agricultural research capacity also rose considerably after 2000 (Stads and El-Siddig 2010).

Tanzania. Tanzania's agricultural R&D system has traditionally been highly dependent on donor funding and development bank loans, which has fluctuated considerably. Since 2005, following years of comparatively low investment levels, the government has stepped up its support of agricultural research,

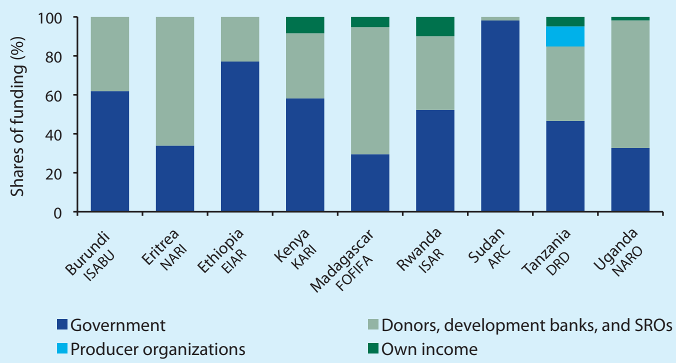
Figure 1—Intensity of agricultural R&D spending by country, 1991, 2001, 2008



Sources: Compiled by author based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes). AgGDP data are from World Bank 2010.

Notes: See Table 1.

Figure 2—Relative shares of funding sources for the main agricultural R&D agencies, 2001-08 average



Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Notes: SROs indicates subregional organizations; "producer organizations" include contributions through export or production levies; "own income includes sales of goods and services and contractual research performed for public and private agencies. Funding shares for some agencies fluctuated over time (see individual ASTI Country Notes). The funding distribution for ISAR–Rwanda is for the period 2005-08 only.

particularly during 2008. Total agricultural research capacity has grown slightly in recent years, with most of the growth taking place in the higher education sector (Flaherty and Lwezaura 2010).

Uganda. Investments in public agricultural R&D in Uganda quadrupled during 2000–08, primarily as a result of increased donor funding and development bank loans, along with growth in government funding to the National Agricultural Research Organisation (NARO) after 2005. Human resource capacity began to rebound in the mid-2000s after a period of falling staffing levels due to losses at NARO in response to low salaries and a hiring freeze (Flaherty, Kitone, and Beintema 2010).

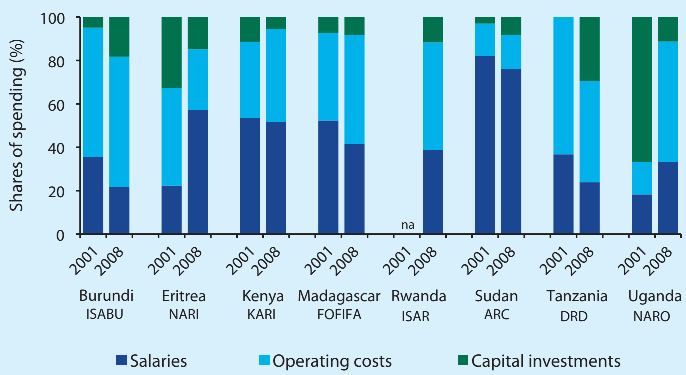
BENCHMARKING KEY INVESTMENT INDICATORS

Spending intensity. Analyzing absolute levels of research expenditures explains only part of the story. Another useful comparison is the commitment to public agricultural R&D investments across countries is to measure total public agricultural R&D spending as a percentage of AgGDP (Figure 1). This relative measure indicates the intensity of investment in agricultural research and not just the absolute level of spending. In 2008, three ASARECA countries had intensity ratios that were above NEPAD's national R&D investment target of at least 1 percent of GDP: Burundi (1.8) Kenya (1.3), and Uganda (1.2). Although intensity ratios provide useful insights into relative investment and capacity levels across countries, they don't take into account the policy and institutional context of agricultural research nor the broader size and structure of a country's agricultural sector and economy (Beintema and Stads 2011a). The high intensity ratio for Burundi, for example, does not reflect a high investment level in agricultural R&D, but rather a negative trend in the country's AgGDP since the mid-1990s. Kenya's intensity ratio remains one of the highest in SSA, but has declined since the early 1990s, meaning that public agricultural R&D spending growth did not keep pace with the country's rising AgGDP. In contrast, Uganda's public agricultural R&D quadrupled since the mid-1990s, outpacing AgGDP growth. As a result, the country's intensity increased from 0.5 in 1991 to 1.2 in 2008. Although total spending in Sudan and Tanzania also increased substantially, their intensity ratios remained low at 0.3 and 0.5 in 2008. The intensity ratios for Eritrea, Ethiopia, Madagascar, and Rwanda were also below the SSA average of 0.6 that same year.

Funding sources. Funding for African agricultural R&D is derived from a variety of sources, including national governments; donors, development banks, and sub-regional organizations (SROs); producer organizations; the private sector; and internally generated revenues.[4] Not surprisingly, variation is significant across the main agricultural research agencies (Figure 2). Funding sources can also differ substantially across time; Figure 2 shows the average distribution for the period 2001-08. The government funded the bulk of agricultural R&D activities of ARC in Sudan and EIAR in Ethiopia; the government also accounted for more than half of total funding of the Institute of Agronomic Sciences of Burundi (ISABU), KARI, and the Rwanda Agricultural Research Institute (ISAR). KARI is one of the best-funded institutes in SSA, receiving constant support from the Kenyan government, attracting large sums of donor funding, and generating its own revenues (Flaherty et al. 2010b).

The main agricultural R&D agencies in other countries are more dependent on external funding. Despite severe cuts in donor and development bank funding to Eritrea's National Agricultural Research Institute (NARI), support from donors and development banks remains its most important funding source (Rahija, Fesha, and Stads 2010), accounting for an average of 66 percent of total funding during 2001-08. With an average share of 65 percent, Madagascar's National Center for Applied Research and Rural

Figure 3—Share of cost categories in total spending the main agricultural R&D agencies, 2001-08



Sources: Compiled by authors based on country-level ASTI survey data (see individual ASTI Country Notes).

Development (FOFIFA) is also highly dependent on donor and development bank funding, including technical support from the French Agricultural Research Center for International Development (CIRAD). This is despite a substantial decline in absolute terms since the termination of a large World Bank-loan funded project. Funding for research activities of the Tanzanian Department of Research and Development (DRD)[5] has traditionally been highly dependent on donors and development banks. However, with a severe reduction in donor and development bank funding since 2005, the government has prioritized research and taken steps to bridge the funding gap (Flaherty and Lwezaura 2010). The sale of goods and services as well as contributions through commodity levies also contribute to funding DRD, although the latter has declined over time reflecting the establishment of commodity-based research institutions in the country. Since the mid-1990s, NARO experienced a strong increase in donor and development bank funding, along with increased government funding since 2005 (Flaherty, Kitone, and Beintema 2010).

Although data were only available up to the year 2008, the share of donors and development banks in overall agricultural R&D funding in Africa is believed to have risen again in recent years, and is expected to increase further. An example is the launch of sizable World Bank projects with an R&D component in four countries as part of the East Africa Agricultural Productivity Program (EAAPP). The overall objective is to generate and disseminate improved agricultural technologies in the participating countries' top priority areas that are aligned with ASARECA's regional priorities. Launched in 2009/10, EAAPP funds cassava research led by NARO in Uganda, rice research by the Ministry of Agriculture in Tanzania, wheat research by EIAR in Ethiopia, and dairy research by KARI in Kenya (World Bank 2009).

Commercializing research outputs can create an additional income stream for agricultural research agencies, but can only be implemented in countries with the necessary policy incentives.[6] Only KARI, FOFIFA, ISAR, DRD, and NARO received some funding through the sale of goods and services, but the overall shares remained limited. Research can also be funded through levies on agricultural production or exports. Commodity levies have been important in funding cash crops such as sugar, coffee, and tea research in Kenya and Tanzania and to a lesser extent, Uganda.

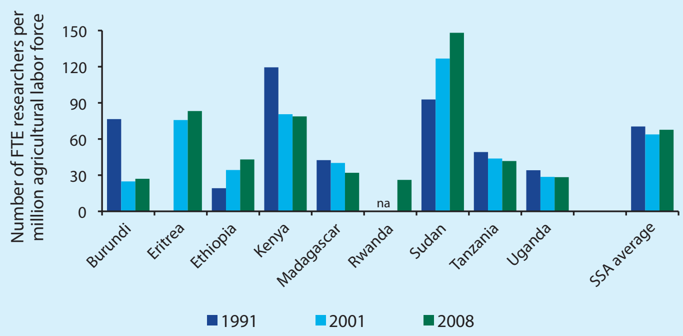
Cost-category shares. The allocation of research budgets across salaries, operation costs, and capital investments affects the efficiency of agricultural R&D. Unsurprisingly, there is a correlation between high donor shares (Figure 3) and low salary shares (Figure 3), Burundi being the exception. In 2008, salaries accounted for a particularly high share in total spending of ARC (76 percent) and toa lesser extent, Eritrea (57 percent), Kenya (52 percent), and Madagascar (42 percent). Although the salary share for ARC in 2008 was particularly high compared to other countries, it actually declined in recent years due to an increase of government contributions towards capital investments. The high increase in the salary share for NARI is a result of the aforementioned strong decline in donor funding over the 2001-08 period. DRD was highly dependent on World Bank funding and capital investments were high, but spending plummeted once the World Bank project ended in 2005. Thereafter, the Tanzanian government increased its commitment to agriculture and agricultural research over time, thereby allowing greater expenditure on salaries, research activities, and equipment and infrastructure. Due to a relatively stronger increase in operating and capital investments, the share of salaries declined despite a strong increase in absolute 2005 values (Flaherty and Lwezaura 2010). In Uganda, sizable World Bank support and, more recently, increased support from the Ugandan government have enabled NARO to invest in institutional development, research programs, rehabilitation of research infrastructure, and postgraduate training. The increase of NARO's salary share from 2001 to 2008 is the result of a 100 percent salary increase in 2005, followed by yearly increases of 10 percent (Flaherty, Kitone, and Beintema 2010).

BENCHMARKING KEY HUMAN CAPACITY INDICATORS

Researcher intensity. Gauging researcher numbers or spending levels against total population or economically-active agricultural population also facilitates a different cross-country comparison than the spending intensity ratio described earlier in this brief. In contrast to its low spending intensity, Sudan employed 148 FTE researchers per million economically active agricultural population in 2008, which was a considerable increase from the 93 FTEs in 1991 (Figure 4). Eritrea and Kenya had also a higher 2008 ratio compared to the overall SSA average of 70 FTEs. In contrast, Burundi, Ethiopia, Madagascar, Rwanda, Tanzania, and Uganda employed far less researchers per million of the economically active agricultural population—ranging from 27 to 43 FTEs in 2008.

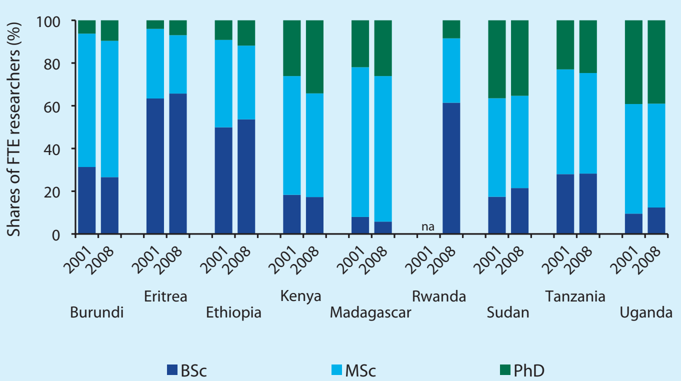
Degree distribution. Qualification levels of agricultural research staff in Sudan and Uganda, the two countries with the highest shares of PhD-trained staff, have not changed significantly since 2001, accounting for close to 40 percent in 2008 (Figure 5). The 2008 share of PhD holders in Kenya was similar, which was a

Figure 4—Intensity of agricultural researchers by country, 1991, 2001, 2008



Sources: Compiled by author based on country-level ASTI survey data and several secondary resources (see individual ASTI Country Notes); Economically active agricultural population data (here labeled as agricultural labor force) are from FAO 2009.

Figure 5—Distribution of agricultural researchers by degree qualification, 2001 and 2008



Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Note: Figure exclude support staff holding university degrees, but who are not classified as researchers (see Figure 6).

substantially increase from the 26 percent in 2001. In contrast, the pool of agricultural R&D staff in Eritrea, Ethiopia, and Rwanda are among the least highly qualified in the SSA region; between roughly one half to two thirds held BSc degrees in 2008. In addition, the share of PhD holders in total FTE research staff in all three countries as well as Burundi accounted for 12 percent or less that same year.

The postgraduate shares of total agricultural staff in ASARECA countries is lower than those in many West African countries, which have maintained relative large pools of well-qualified researchers. The latter stem in large part from training programs that took place during the 1970s and 1980s, when donors or World Bank-financed projects funded them. These trainings were often followed by long periods of recruitment restrictions. As a result, many West African countries are experiencing a rapidly aging pool of scientists (Beintema and Stads 2011a).[7] Some ASARECA countries have also aging research capacities. FOFIFA, for example, has lost a large number of PhD- and MSc-qualified researchers in recent years and many of its most senior researchers will retire soon (Stads and Randriamanamisa 2010). Despite an increase in capacity, ARC researchers' average degree levels have consistently declined since the 1980s. During 2004-09, for example, the corporation lost 60 PhD-qualified researchers, mainly due to retirement, who are typically being replaced by junior staff holding BSc and, occasionally, MSc degrees (Stads and El-Siddig 2010). Due to a civil service hiring freeze, research staff at DRD are over 45 years old. With many PhD-qualified staff recently retiring, the department has recruited many new staff, but they tend to be younger and have often only BSc degrees (Flaherty and Lwezaura 2010). One of the main challenges for Madagascar, Sudan, and Tanzania should, therefore, be an intensification of the intake of junior staff and the insurance that they receive high-level training.

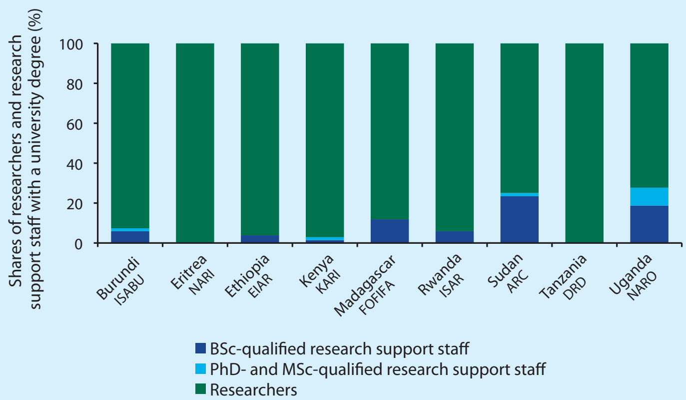
KARI also had an aging staff situation due to a new hire restriction. Furthermore, similarly to many other government agricultural R&D agencies in Africa, staff retention has become a major concern for KARI. KARI has put into place a number of retention strategies, including regular staff performance evaluations, increased promotion possibilities, better medical benefits, and study leave opportunities. To address the aging of staff, KARI and other research institutes successfully requested the government to increase the retirement age of scientists from 55 to 65 (Flaherty et al. 2010b).

Agricultural research staff in Eritrea and Ethiopia grew significantly despite highly unstable funding levels, but only a small share of staff are holding postgraduate degrees. During 2001-8, the share of BSc-degree holders increased from 63 to 66 percent in Eritrea and from 50 to 54 percent in Ethiopia. Rwanda's agricultural staff is also relatively younger and has lower university degrees compared with other ASARECA countries. Training staff should also be a primary focus of these three countries in the upcoming years.

In contrast to the other main agricultural research institutes, NARO does not have an increasing pool of researchers approaching retirement age nor has it serious difficulties filling researcher positions given the high, and increasing, numbers and quality of post graduates from Makerere and other Universities (Flaherty, Kitone, and Beintema 2010).

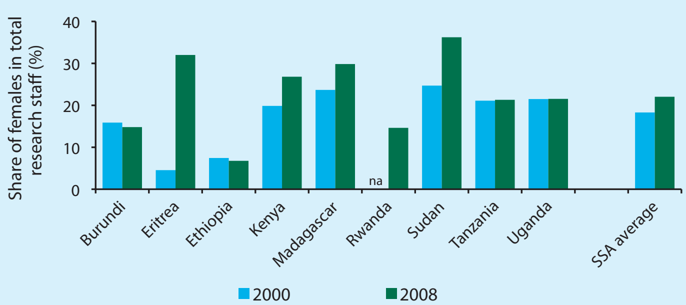
University-qualified research support. A number of ASARECA countries have an increasing pool of support staff (technicians, research assistants, laboratory assistants) holding BSc, MSc, and occasionally PhD degrees, but who are not classified as researchers (Figure 6). For ARC and NARO, technicians with degrees accounted for about one-fifth of the total university degree holders (researchers and technicians) in 2008. For NARO, this means that one half of all the technicians have obtained a university degree, and most obtained this degree on their own, and not through financial backing by NARO. Although the number of researcher positions at NARO has increased recently, promotional opportunities are limited; applicants must have at least a MSc degree and meet other specific requirements

Figure 6—Distribution of agricultural researchers and university-qualified research support staff, 2008



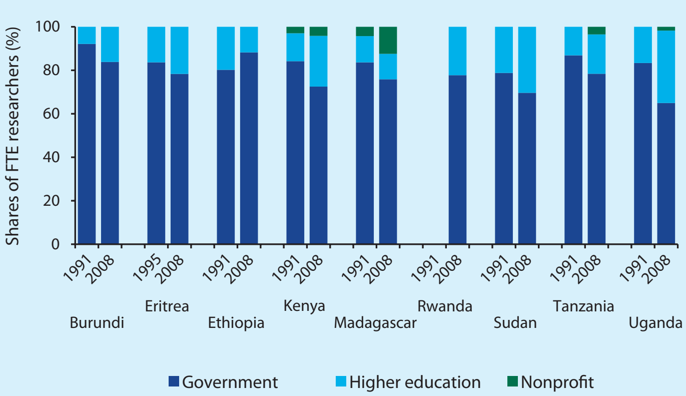
Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Figure 7—Share of female research staff, 2000 and 2008



Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Figure 8—Distribution of agricultural researchers by institutional category, 1991 and 2008



Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

(Flaherty, Kitone, and Beintema 2010). In contrast, staff at DRD in Tanzania are promoted to researcher status when they complete their BSc degrees (Flaherty and Lwezaura 2010).

Female shares. There is an urgent need for a greater representation of women in agricultural research, particularly in SSA, where women are a large percentage of the agricultural workforce. The overall share of women in SSA's total agricultural research staff has increased from 18 percent in 2000 to 22 percent in 2008 (Figure 7). This trend was not apparent across the ASARECA countries. The participation of women in agricultural research has increased substantially to about one-third of total FTE researchers in Eritrea and Sudan. Female shares also increased in Kenya and Madagascar with 7 and 6 percentage points, respectively. For the other countries, the total share of female research staff remained fairly constant or declined slightly. Burundi, Ethiopia, and Rwanda had lower female shares than the SSA regional average in 2008.

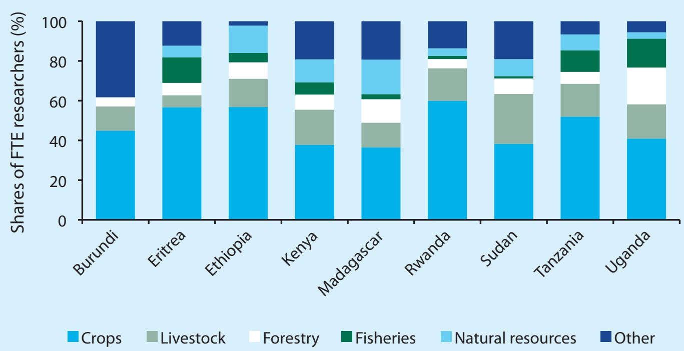
BENCHMARKING OTHER KEY INDICATORS

Institutional distribution. The current structure of agricultural research institutions varies widely by country. In most of the region's smaller countries, agricultural research is undertaken by a handful of government agencies and university faculties. For example Rwanda had 2 government and 3 higher education agencies and Eritrea 2 government and 1 higher education agency involved in agricultural R&D. In larger countries like Sudan and Kenya, the systems are more complex, with a large number of agencies existing side by side.[8] In both countries, a large and increasing number of higher education agencies are conducting agricultural R&D. In both countries, this was the result of the establishment of several new agricultural colleges and departments. In Sudan, the overall quality of agricultural research conducted at these new faculties, however, is generally poor, based on underfunding and a total lack of research management structures (Stads and El-Siddig 2010).[9]

The institutional composition of national agricultural R&D has gradually shifted over the last few decades. Overall, African agricultural research is still dominated by the government sector though its relative share is declining. One exception is Ethiopia, where the establishment of the RARIs led to an increase in the role of the government in agricultural research from 1991 to 2008 (Figure 8). Noteworthy is the strong decline of government-based agricultural research in Uganda; from 83 percent in 1991 to 65 percent in 2008. This was the result of a strong increase in the research capacity at the country's main higher education agency, Makerere University.

Despite the high and increasing number of higher education agencies conducting agricultural research in a number of countries, the individual capacity of most of them (in terms of FTE researcher numbers) is very small. Faculty staff spend the majority of their time teaching. While the amount of time spent on research by faculty staff has gradually risen over the years, it still represented less than 25 percent in 2008.

Figure 9—Distribution of agricultural researchers by major subsector, 2008



Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Agricultural R&D involvement by the nonprofit sector remained small and occurred only in Kenya, Madagascar, Tanzania, and Uganda. While nonprofit institutions often have more freedom than publicly-funded entities, they are often linked to producer organizations and receive most of their funding via levies on production or exports. Examples include agencies conducting research on tea (Kenya and Tanzania), coffee (Uganda, Kenya, Tanzania), and sugar (Kenya). Madagascar is one of the few countries in Africa where non-governmental organizations (NGOs) are involved in agricultural research. Their share in the country has increased and accounted for 12 percent of total research capacity in 2008.

Little information could be accessed on capacity or expenditure trends in the private agricultural R&D. Most private for-profit companies still outsource their research to government agencies or universities or they import technologies from abroad. Only a limited number of private companies operate their own research programs, and when they do so, often employ only a handful of researchers (Beintema and Stads 2006).

Research allocation by subsector. The allocation of resources among various lines of research is a significant policy decision, so the ASTI surveys collected detailed information on the allocation of FTE researchers across specific commodity areas. Large differences were observed across countries reflecting differences in natural endowments and research priorities (Figure 9). Crop research accounted for between 52 and 60 percent of the FTE researchers in Eritrea, Ethiopia, Rwanda, and Tanzania. With a share of 25 percent, livestock featured prominently on the research agenda of Sudan. Livestock research ranged between 12 and 18 percent in all the other ASARECA countries, with the exception of Eritrea, where only 6 percent all agricultural FTE researchers focused on livestock-related issues. Fisheries research represented an important part of total agricultural R&D activities in Eritrea, Tanzania, and Uganda (13, 11, and 15 percent); forestry represented an important part these activities in Madagascar and Uganda (12 and a 19 percent); and natural resources represented an important part of these activities in Ethiopia, Kenya, and Madagascar (12, 11, and 17 percent).

Table 2—Crop researchers by major crop item, 2008

Country	Major crop items
Burundi	Coffee (14%), vegetables (13%), fruit (11%), rice (9%), potatoes (7%), and maize (5%)
Eritrea	Sorghum (36%), wheat (14%), millet (8%), barley (8%), vegetables (8%), maize (7%), and potatoes (6%)
Ethiopia	Wheat (18%), maize (10%), sorghum (7%), barley (7%), vegetables (7%), potatoes (6%), and coffee (5%)
Kenya	Maize (18%), coffee (10%), vegetables (8%), potatoes (8%), wheat (8%), other fruit (7%), bananas (6%), and sorghum (5%)
Madagascar	Rice (33%), fruit (12%), coffee (9%), maize (8%), vegetables (8%), and ornamentals (5%)
Rwanda	Potatoes (12%), maize (11%), other fruits (10%), bananas (9%), rice (9%), vegetables (7%), coffee (7%), wheat (7%), cassava (6%), millet (6%), and sorghum (5%)
Sudan	Sorghum (12%), vegetables (11%), cotton (11%), wheat (11%), fruit (8%), groundnuts (5%), and millet (5%)
Tanzania	Maize (12%), rice (6%), and cassava (6%)
Uganda	Coffee (21%), bananas (20%), cassava (7%), and oil palm (6%)

Sources: Compiled by author based on country-level ASTI survey data (see individual ASTI Country Notes).

Notes: Major crop items are defined as those on which at least 5 percent of a country's crop researchers focused. Fruits include bananas, except for Kenya, Rwanda, and Uganda, where bananas alone accounted for 5 percent or more of the country's crop research.

Crop research allocation. Understandably, some important differences in the focus of crops research exist across countries (Table 2). Wheat was the focus of at least 10 percent of the crop researchers in Eritrea, Ethiopia, and Sudan while research on this crop was negligible in Madagascar and Uganda. Sorghum and rice accounted for about one third of total crop research in Eritrea and Madagascar, respectively. Sorghum was also an important crop in Sudan (12 percent), Ethiopia (7 percent), and Kenya and Rwanda (5 percent). Rice was further important in Burundi and Rwanda (9 percent each) and Tanzania (6 percent). Coffee was the main export crop under research, accounting for 21 percent in Uganda, 14 percent in Burundi, and 7 to 10 percent in Kenya, Madagascar, and Rwanda.

CONCLUDING REMARKS

Since the turn of the millennium, total public agricultural R&D investments and capacities increased in most ASARECA countries. The growth in investments was largely the result of increased government commitments, although agricultural R&D continues to be highly dependent on donor funding and development bank loans. Furthermore, increased government contributions were most often directed toward salary increases and improvements to infrastructure and equipment. Despite the increases in overall numbers of agricultural researchers, average qualification levels in some countries deteriorated while other countries are facing an increasing aging researcher pool. The latter is often the result of recruitment freezes and increasing staff retention.

Building on strategic recommendations of highly influential reports (IAC 2004, World Bank 2007a, IAASTD 2008, Lele et al. 2010) and new evidence collected through ASTI, Beintema and Stads (2011a) this brief outlines four key areas that need consideration:

- Higher levels of investments are needed ***to counteract decades of underinvestment in agricultural R&D***, because overall investment levels in most SSA countries are still below the levels required sustaining agricultural R&D needs. This is despite the increased commitments of governments, donors, and development banks in recent years in some countries.
- Stable and sustainable levels of government funding are needed ***to halt excessive volatility in yearly investment levels*** caused by a high dependency on unstable influx of donor funding and development bank loans. Governments will need to identify long-term national R&D priorities and design relevant programs while donor funding will need to be better aligned with these priorities.
- Governments and donors need ***to address the existing and imminent challenges in human resource capacity*** to enable agricultural R&D to satisfactorily respond to emerging global challenges. This includes an expansion of investments in agricultural higher education to allow universities to increase the number and size of PhD and MSc programs and to improve curricula of existing programs.
- National and regional agricultural R&D agencies will need ***to maximize regional and subregional cooperation***. This is because the many small countries in SSA often lack the required critical mass of agricultural capacity and hence face enormous challenges in producing or accessing relevant, high-quality research outputs.

These four key areas will have to be addressed by government, donors, and other stakeholders will African agricultural R&D overcome the various investment and capacity challenges it faces.

NOTES

1 ASTI plans to transform the program from an ad-hoc data collection system to a sustainable system of up-to-date data compilation and analysis, including institutionalization of the activities at the national level. This will include a geographical expansion to benchmark countries, such as DR Congo, that were not covered in previous survey rounds.

2 A total of 32 Sub-Saharan African countries were included in the survey round. Combined, they contributed more than 90 percent of the region's agricultural gross domestic product (AgGDP).

3 These trends have been published in a series of ASTI Country Notes, which are listed in the reference section and are available at http://www.asti.cgiar.org/publications/ssa. Underlying datasets can be downloaded from ASTI's Data Tool at http://www.asti.cgiar.org/data.

4 See Beintema and Stads 2011a and Echeverría 2009 for an overview on different funding sources and mechanisms.

5 All livestock R&D capacity was transferred from DRD in 2001 to form the Department of Research, Training, and Extension (DRTE). DRTE did not become operationally independent of DRD until 2006.

6 In many SSA countries, such as Sudan, internally generated income is channeled back to the treasury, eliminating any incentive for research agencies to explore contract-based research for the private sector (Beintema and Stads 2011a).

7 For example, Senegal has one of the oldest pools of agricultural researchers in SSA; in 2007 59 percent of its researchers were 50 years or older (Beintema and Stads 2011a).

8 For agency directories, please see the country pages on the ASTI website.

9 A large number of universities in Sudan were only established in the 1990s with the expansion of the higher education sector and the associated spread of institutions across the country in response to the national government's 1995 subdivision of the country into 26 rather than nine states.

REFERENCES

ASTI (Agricultural Science and Technology Indicators). ASTI website. http://www.asti.cgiar.org.

Beintema, N. M., and G. J. Stads. 2006. *Agricultural R&D in Sub-Saharan Africa: An era of stagnation.* ASTI Background Report. Washington, DC: International Food Policy Research Institute.

Beintema, N. M. and G. J. Stads. 2008. *Measuring Agricultural Research Investments: A Revised Global Picture*. ASTI Background Note. Washington, DC: International Food Policy Research Institute.

———. 2011a. *African Agricultural R&D in the New Millennium: Progress for Some, Challenges for Many*. IFPRI Food Policy Report. Washington, DC: International Food Policy Research Institute.

———. 2011b. *ASTI Toolkit—Monitoring Agricultural R&D Capacity and Investment Indicators: A Practitioner's Guide to ASTI's Methodologies & Data Collection Standards*. Washington, DC: International Food Policy Research Institute. (Forthcoming)

Echeverría, R. G., and N. M. Beintema. 2009. *Mobilizing Financial Resources for Agricultural Research in Developing Countries: Trends and Mechanisms*. Rome: Global Forum on Agricultural Research.

FAO (Food and Agriculture Organization of the United Nations). 2009. FAOSTAT Database. Accessed March 23, 2010. http://faostat.fao.org/site/452/default.aspx.

Flaherty, K., and D. Lwezaura. 2010. *Tanzania*. ASTI Country Note. Washington, DC, and Dar es Salaam: International Food Policy Research Institute and Department of Research and Development.

Flaherty, K., F. Kelemework, and K. Kelemu. 2010. *Ethiopia*. ASTI Country Note. Washington, DC, and Addis Ababa: International Food Policy Research Institute and Ethiopian Institute of Agricultural Research.

Flaherty, K., D. Kitone, and N. M. Beintema. 2010. *Uganda*. ASTI Country Note. Washington, DC, and Entebbe: International Food Policy Research Institute and National Agricultural Research Organisation.

Flaherty, K. and J. M. Munyengabe. 2011. *Rwanda*. ASTI Country Note. Washington D.C. and Kigali: International Food Policy Research Institute and Rwanda Agriculture Research Institute.

Flaherty, K., F. Murithi, W. Mulinge, and E. Njuguna. 2010b. *Kenya*. ASTI Country Note. Washington, DC, and Nairobi: International Food Policy Research Institute and Kenya Agricultural Research Institute.

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

IAC (InterAcademy Council). 2004. *Realizing the Promise and Potential of African Agriculture: Science and Technology Strategies for Improving Agricultural Productivity and Food Security in Africa.* Amsterdam: IAC.

Lele, U., J. Pretty, E. Terry, and E. Trigo. 2010. *Transforming Agricultural Research for Development*. Report prepared for the Global Conference on Agricultural Research for Development, Montpellier, France, March 28–31. Rome: Global Forum on Agricultural Research.

NEPAD (New Partnership for Africa's Development, Office of Science and Technology). 2006. *Africa's Science and Technology Consolidated Plan of Action*. Pretoria: NEPAD.

NEPAD–CAADP (New Partnership for Africa's Development–Comprehensive Africa Agriculture Development Programme). 2010. Pillar 4: Agricultural Research. Accessed November 2010. http://www.nepad-caadp.net/pillar-4.php.

Rahija, M., I. Fesha, and G. J. Stads. 2010. *Eritrea*. ASTI Country Note. Washington D.C. and Asmara: International Food Policy Research Institute and National Agricultural Research Institute.

Stads, G. J., and K. El-Siddig. 2010. *Sudan*. ASTI Country Note. Washington, DC, and Wad Madani: International Food Policy Research Institute and Agricultural Research Corporation.

Stads, G. J., and L. Ndimurirwo. 2011. *Burundi*. ASTI Country Note. Washington D.C. and Bujumbura: International Food Policy Research Institute and l'Institut des Sciences Agronomiques du Burundi.

Stads, G. J. and R. Randriamanamisa. 2010. *Madagascar.* ASTI Country Note. Washington D.C. and Antananarivo: International Food Policy Research Institute and National Center of Applied Research and Rural Development.

World Bank. 2007. *World Development Report 2008: Agriculture for Development*. Washington, DC.

———. 2009. *Project Appraisal Document on Three Proposed Credits in the Amount of SDR 20.1 Million (US$30 Million Equivalent) to the Federal Democratic Republic of Ethiopia, of SDR 20.1 Million (US$30 Million Equivalent) to the Republic of Kenya, of SDR 20.1 Million (US$30 Million Equivalent) to the United Republic of Tanzania for a Total of SDR 60.3 Million (US$90 Million Equivalent) for Eastern Africa Agricultural Productivity Program APL1 in Support of the First Phase of the Eastern Africa Agricultural Productivity Program*. Report 48295-AFR. Washington, DC.

———. 2010. *World Development Indicators*. Washington, DC. Accessed November 2010. http://data.worldbank.org/data-catalog/world-development-indicators/wdi-2010.

Acknowledgements

This publication was developed with funding from the Bill & Melinda Gates Foundation and additional support from the International Food Policy Research Institute and the Association for Strengthening Agricultural Research in Eastern and Central Africa. The author thanks their country collaborators and the close to 130 agricultural research agencies that participated in the national survey rounds; without their commitment, the publication would not have been possible. The author also thanks Michael Rahija for his excellent help in preparing this report.

IFPRI-ROME
Agricultural Science and Technology Indicators (ASTI) initiative
c/o ESA, Food and Agriculture Organization (FAO)
Viale delle Terme di Caracalla • 00153 Rome, Italy
Telephone: +39.06.570.53192 / 56334 • Skype: ifpriromeoffice
Fax: +39.06.570.55522 • Email: asti@cgiar.org
www.asti.cgiar.org

ASARECA
Plot 5 Mpigi Road
P. O. Box 765 Entebbe, Uganda
Telephone: +256.414.320.556 / 212
Fax: +256.414.321126 • Email: secretariat@asareca.org
www.asareca.org

ASTI 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.

IFPRI is one of 15 agricultural research centers that receive their 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).

ASARECA is a non-political organization of the National Agricultural Research Systems (NARS) of ten countries: Burundi, D. R. Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania and Uganda. It aims at increasing the efficiency of agricultural research in the region so as to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture.