

GHANA

By Gert-Jan Stads and Joseph O. Gogo

This brief reviews the major investment and institutional trends in Ghanaian public agricultural research since the early 1970s, including a new set of survey data for the 1990s collected under the Agricultural Science and Technology Indicators (ASTI) initiative (IFPRI-ISNAR-CORAF/WECARD 2002-2003).¹

INSTITUTIONAL DEVELOPMENTS

In 2001, the rural population of Ghana represented 64 percent of the total population and the agricultural sector accounted for 36 percent of total gross domestic product (GDP) and over 50 percent of total export earnings (World Bank 2003).

Consequently, like many developing countries in Africa and elsewhere, agriculture plays a pivotal role in Ghana's economy, and, by association, agricultural research and development (R&D) is extremely important. We identified 29 agencies involved in agricultural research in Ghana in 2001.² Collectively they employed 475 full-time equivalent (fte) researchers and spent 35 billion Ghanaian cedis on agricultural R&D—equivalent to 62 million 1993 international dollars (Table 1).³

Agricultural research activities under the umbrella of the Council for Scientific and Industrial Research (CSIR) accounted for roughly two-thirds of both total research spending and agricultural researchers. CSIR was established in 1968 to coordinate all scientific research in Ghana (see a *Short History of Government-Based Agricultural Research* on page 2). It currently oversees 13 research agencies, nine of which conduct agricultural research: the Animal Research Institute (ARI), the Crops Research Institute (CRI), the Soil Research Institute (SRI), the Oil Palm Research

Table 1—Composition of agricultural research expenditures and total researchers, 2001

Type of agency	Spending		Researchers ^a (fte's)	Share		Agencies in sample ^b (number)
	1999 cedis (millions)	1993 international dollars		Spending (percent)	Researchers	
CSIR ^c	23,011.5	40.5	323.8	65.4	68.2	9
CRIG ^d	5,526.6	9.7	35.0	15.7	7.4	1
Other government ^e	1,057.1	1.9	32.9	3.0	6.9	4
Higher education ^f	5,586.9	9.8	82.8	15.9	17.4	15
Total	35,182.1	61.9	474.5	100	100	29

Source: Compiled by authors from survey data (IFPRI-ISNAR-CORAF/WECARD 2002-03) and ACU (various years).

^aIncludes national and expatriate staff.

^bSee note 2 for details on all agencies.

^cExpenditures for FRI are estimates based on previous years.

^dExpenditures for CRIG are estimates based on previous years and combined expenditures per researcher for the CSIR institutes.

^eExpenditures for APD and AESD are estimates based on average expenditures per researcher for the CSIR institutes combined.

^fExpenditures for the higher-education sector are estimates based on average expenditures per researcher for the government sector. The 303 staff at the 15 higher-education agencies spent between 10 and 100 percent of their time on research, resulting in 82.8 fte researchers.

KEY TRENDS

- Agricultural research financing and expenditure growth in Ghana stagnated during the 1990s, although the number of researchers gradually increased.
- The agricultural research agencies of the Council for Scientific and Industrial Research (CSIR) accounted for about two-thirds of Ghana's total spending and research staff in 2001.
- Although the government legislated that by 2001 CSIR agencies should derive 30 percent of their budget from private sources, only the Oil Palm Research Institute (OPRI) reached this goal. Socially oriented agencies under CSIR are significantly less well-placed to generate their own funds than the more commercially oriented agencies.
- Government and donor contributions remain the primary sources of funding for agricultural research in Ghana.
- Private-sector involvement in agricultural research is minimal.

ABOUT ASTI

The Agricultural Science and Technology Indicators (ASTI) Initiative consists of a network of national, regional, and international agricultural R&D agencies managed by IFPRI and ISNAR. The initiative compiles, processes, and makes available internationally comparable data on institutional developments and investments in public and private agricultural R&D worldwide, and analyses and reports on these trends in the form of occasional policy digests for research policy formulation and priority setting purposes.

Primary funding for the ASTI initiative was provided by the CGIAR Finance Committee/World Bank with additional support from the Australian Center for International Agricultural Research (ACIAR), the European Union, and the U.S. Agency for International Development (USAID).

Institute (OPRI), the Food Research Institute (FRI), the Forestry Research Institute of Ghana (FORIG), the Plant Genetic Resources Centre (PGRC), the Savanna Agricultural Research Institute (SARI), and the Water Research Institute (WRI).^{4,5} The CSIR Secretariat, the central administrative body for CSIR's agencies, falls within the Ministry of Environment, Science and Technology (MEST) and is headquartered in Accra. CSIR's institutes and centers are scattered across country, each managed by a council-appointed board. A key task of the boards is to evaluate, authorize, and examine research and commercialization programs proposed by the institute and center directors (Gage and Sarr 2001).

In 2001, the Government of Ghana legislated changes to CSIR's mandate and operations with a view to addressing private-sector issues and introducing market principles. The legislation introduced a private-sector funding target of 30 percent of each agency's budget. The Agricultural Services Sub-Sector Investment Program (AgSSIP), funded through a World Bank loan, the national government and contributions from other donors, was approved in June 2000 to facilitate and support the achievement of this shift toward commercialization. A key component of the program is sustainable financing of research by restructuring and strengthening agricultural research and extension and improving farmer and other stakeholder participation in the governance and financing of agricultural research (Gage and Sarr 2001).

Of the agencies not associated with CSIR, the Cocoa Research Institute of Ghana (CRIG) is the most significant. CRIG is the research division of the Ghana Cocoa Board (COCOBOD), operating under the Ministry of Finance. In 2001 it employed 35 fte researchers, and focuses primarily on issues relating to the production of Ghana's primary export crop, cocoa. It also focuses on crops like coffee, kola, sheanut, and other indigenous oil tree crops. Research is conducted across seven scientific divisions: Agronomy and Soil Science, Plant Breeding, Entomology, Plant Pathology, Physiology and Biochemistry, Social Science and Statistics, and New Products Development. Headquartered in Tafo, CRIG comprises three substations and three plantation farms (CRIG 2003).

Four other government agencies are involved in

agricultural research. The Biotechnology and Nuclear Agricultural Research Institute (BNARI), under MEST, employed 19 fte researchers in 2001 and focuses on the use of biotechnology and nuclear technologies to address sustainable agriculture, health, and industrial needs in Ghana. It has three departments: Animal Science, Plant and Soil Science, and Food Science and Radiation Processing (BNARI 1994). The Ministry of Food and Agriculture (MOFA) has three units that conduct some agricultural research: the Agricultural Engineering Services Directorate (AESD), the Animal Production Directorate (APD), and the Marine Fisheries Research Division (MFRD).

The 15 higher-education agencies involved in agricultural research in 2001 accounted for 17 percent of human resources. Most of this research was conducted at Ghana's five main universities: the University of Ghana (UG), the Kwame Nkrumah University of Science and Technology (KNUST), the University of Cape Coast (UCC), the University of Development Studies (UDS), and the University College of Education of Winneba (UCEW).⁶ With 32 fte researchers in 2001, UG's Faculty of Agriculture is the largest agricultural research entity in our higher-education sample. Crop, animal, soil, and other research is conducted by the faculty's 8 departments, including 3 research stations located in three different agroecological zones. The second-largest agricultural research entity in the higher-education sector is the Kumasi-based Faculty of Agriculture at KNUST, which had 15 fte researchers in 2001 and a research focus similar to that of the Faculty of Agriculture at UG.

Privately conducted research has effectively been limited to the nonprofit sector, undertaken either by individuals or small consultancies. Minimal collaboration has occurred with private international organizations often on an ad hoc basis; hence these activities are not included in the data analysis of this report (Dordunoo and Dogbey 2002). No private for-profit organizations conducting agricultural research were identified in Ghana; CSIR's agencies, however, have begun to conduct limited research for the private sector as part of the move toward commercialization. Some of the beneficiaries of FRI's research for example, include Cadbury and Lever Brothers; WRI carries

A Short History of Government-Based Agricultural Research

The establishment of the Government Botanical Gardens at Aburi in 1890 marked the beginning of agricultural research in Ghana. In those early days, research focused primarily on oil palm, cocoa, and rubber. The gardens constituted the basis for the Department of Agriculture, which in turn established various agricultural experiment stations throughout the country between 1900 and 1910. In addition to the Department of Agriculture, several regional research organizations were established throughout British West Africa in the late 1940s and early 1950s. With independence from British rule in 1957, the headquarters of the West African Cocoa Research Institute and some facilities of the West African Institute for Oil Palm Research and the West African Timber Borer Research Unit were nationalized.

In 1968, the Ghana Academy of Sciences, established a few years prior, was restructured as the Ghana Academy of Arts and Sciences, and the Council for Scientific and Industrial Research (CSIR). At that time, CSIR assumed responsibility for the coordination of all scientific research in Ghana. It exists to this day, overseeing 13 research agencies, 9 of which with varying agricultural focuses. The Cocoa Research Institute of Ghana (CRIG) was founded in 1938 as the Central Cocoa Research Station of the Department of Agriculture and at that time took over the long-standing cocoa research at the Aburi Gardens. The station (CRIG as of 1960) fell under the supervision of CSIR from its establishment until 1973, when it was transferred to the Cocoa Marketing Board, later succeeded by the Ghana Cocoa Board (COCOBOD). CRIG's initial focus was cocoa research, but over the years this has broadened to include other crops. The Department of Biology, Food and Agriculture in the National Nuclear Research Institute was established in 1981, primarily focusing on the use of biotechnology and nuclear technologies to address sustainable agriculture. In 1993, it became the Biotechnology and Nuclear Agriculture Research Institute (BNARI).

Government-based agricultural research has remained largely unchanged since the early 1970s. CSIR continues to be the primary implementing agency for agricultural research in Ghana, although legislation passed in 1996 heralded a shift toward commercialization of CSIR's agricultural research.

Sources: Roseboom and Pardey (1994) and BNARI (1994).

out research in close alliance with the Ghana Bauxite Corporation, the Accra Brewery, and other private-sector enterprises; and ARI reported collaboration with the Ghana Agrofood Company and the Cocoa Processing Company, among others (CSIR 2003). Presumably these kinds of activities will expand in the coming years as the implementation of AgSSIP continues.

The recent establishment of a competitive grant scheme has increased collaboration across the various CSIR agencies and between CSIR agencies and the universities. Cooperation also exists between the government and higher-education agencies on the one hand, and regional and international agencies on the other. OPRI, for instance, works closely with oil palm research agencies in Malaysia, Cuba, Indonesia, and Papua New Guinea (CSIR 2003). International agencies play an important role in CSIR's research programs as well. CSIR collaborates with various United Nations agencies, such as Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP) and international science entities like the Commonwealth Science Council, the Pan-African Union for Science and Technology, and the African Academy of Sciences. CSIR also undertakes several collaborative research projects with various centers of the Consultative Group on International Agricultural Research (CGIAR) (CSIR 2003).

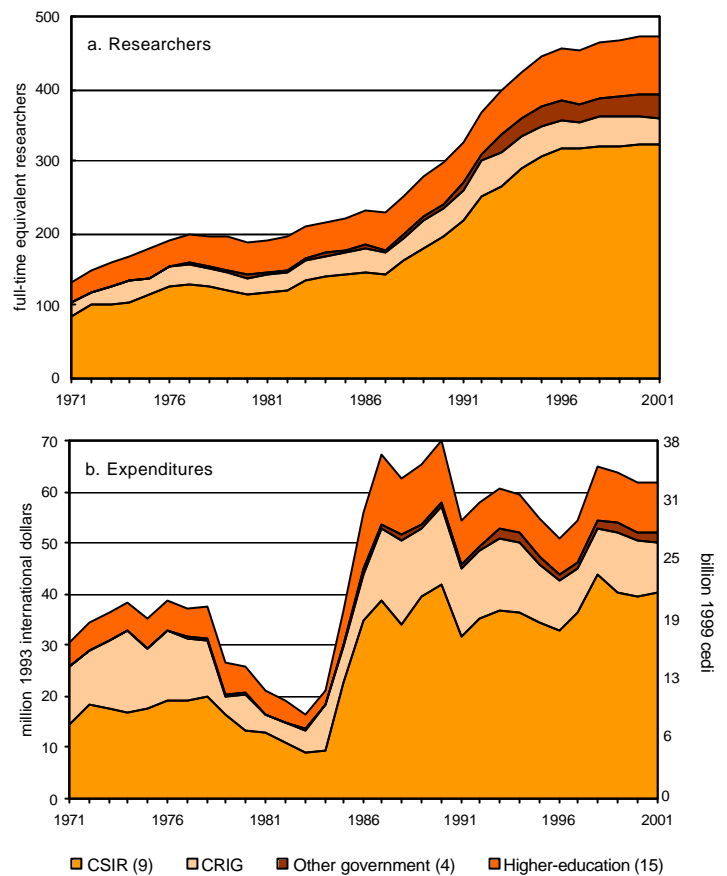
HUMAN AND FINANCIAL RESOURCES IN PUBLIC AGRICULTURAL R&D

Overall Trends

The total number of fte agricultural researchers in Ghana increased rapidly during 1981–96, averaging 6.6 percent per year, but the annual growth rate slowed to 1.0 percent during 1996–2001 (Figure 1a) because of a government regulation that halted staff recruitment in most state-owned organizations (Dordunoo and Dogbey 2002).⁷ The combined number of fte researchers at the nine CSIR institutes increased from 217 in 1991 to 324 in 2001, and in the higher-education agencies, the annual growth rate was 3.9 percent for the same period. In contrast, total fte researcher numbers declined at CRIG from 44 in 1991 to 35 in 2001. Total expatriate researcher numbers fell overall; in the government sector, for example, 12 expatriate fte researchers were employed in 1991 but there were none by 2001.

After a period of negative growth during the late 1970s and early 1980s—a result of domestic policy distortions, economic mismanagement, severe droughts, and a worldwide recession (Roseboom and Pardey 1994)—agricultural R&D spending increased greatly between 1983 and 1991 (17.4 percent per year). Since then, growth in total spending was at 1.1 percent per year, although significant year-to-year fluctuations occurred (Figure 1b). Government salaries were not fully adjusted in line with mass inflation during much of the 1970s and early 1980s, which led to a significant erosion of real salaries and eventually a mass departure of skilled research staff.⁸ During 1983–91 this trend reversed as salaries of senior researchers increased more than eight-fold in real terms between 1983 and 1991, often at the expense of sound financial management (Tabor et al. 1992; Roseboom and Pardey 1994). This accounts for the rise in spending in the 1980s.

Figure 1^{3/4} Public agricultural R&D trends, 1971–2001

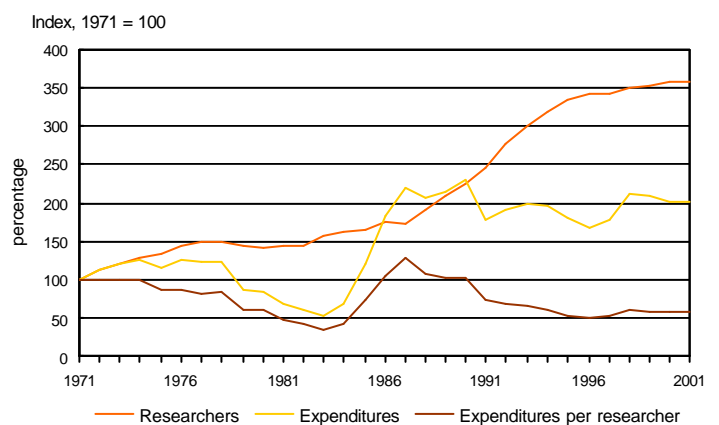


Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03), Roseboom and Pardey (1994), and ACU (various years).

Notes: Figures in parentheses indicate the number of agencies in each category. CSIR includes its current nine institutes as well as WRI's predecessors, IAB and WRI. Underlying data are available at the ASTI website (www.asti.cgiar.org).

Steadily growing research staff and stagnant research expenditure growth throughout the 1990s caused spending per scientist to fall from \$166,000 in 1991 to \$130,000 in 2001 (Figure 2). Once again however, this average masks wide variation across the agencies in our sample.

Figure 2^{3/4} Trends in public expenditures, researchers, and expenditures per researcher, 1971–2001

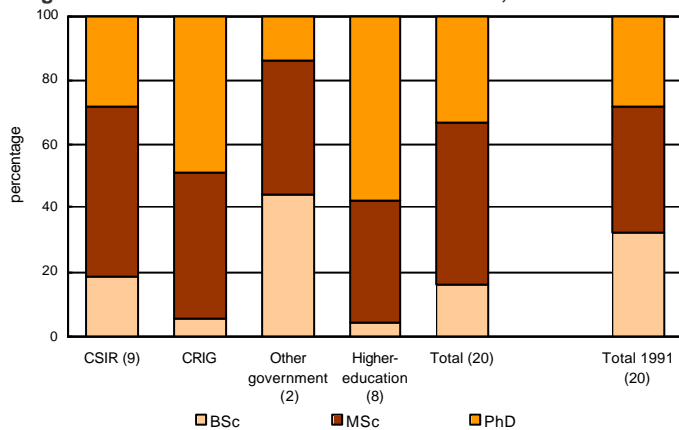


Source: Figure 1.

Human Resources

Staff qualifications improved considerably in the 1990s. In 1991, 68 percent of the 306 fte researchers in a 20-agency sample held postgraduate degrees. In 2001, 84 percent of the 431 researchers in the same sample had some postgraduate-level training, and close to one-third held a doctorate degree (Figure 3). A higher proportion of university staff held PhD degrees compared with staff at CSIR and other government agencies, which is in line with findings in other African countries (Beintema 2003; Pardey et al. 1997). Of note is the increase in the education level of scientists at CRIG: 63 percent of CRIG's researchers held postgraduate degrees in 1991, while this level had risen to 94 percent by 2001 mainly because of BSc staff attaining MSc degrees.

Figure 3 Educational attainment of researchers, 2001



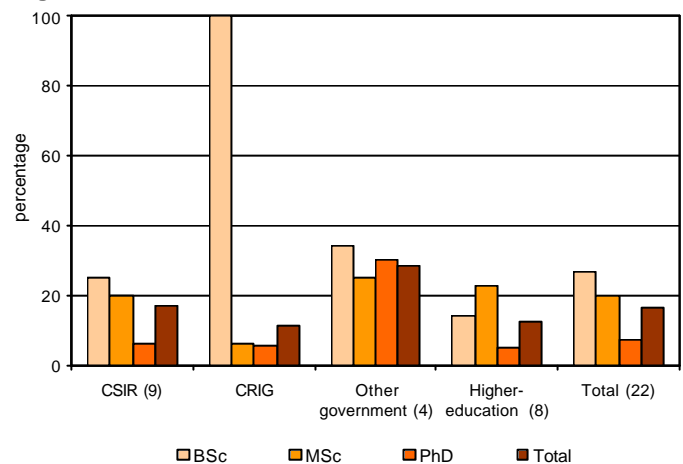
Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).

Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff.

Most of the training of CSIR researchers throughout the 1990s was funded by National Agricultural Research Project (NARP), which was primarily funded by a World Bank loan. By 2001, 66 MSc and 44 PhD students had completed training under NARP both in Ghanaian universities and abroad, 5 MSc and 14 PhD students were still undertaking overseas training, and 17 MSc and 25 PhD students were still studying in Ghanaian universities. NARP also provided over 20 short courses to update the skills of scientists, librarians, and technicians within the agricultural research sector (CSIR 2003). More recently, AgSSIP has allocated higher-education funding for 74 staff over the 2000–09 period, 31 of which will receive PhD-level training. Some researchers will study abroad, and many locally trained postgraduates will be encouraged to participate in 6–12 month programs in regional or international research centers or universities so as to keep abreast of important developments (World Bank 2000). All but one CSIR agency reported an increase in the number of researchers with doctorate degrees over the past 10 years; however many researchers departed once their training was completed. CRI, for instance, has recently lost senior breeders to the International Maize and Wheat Improvement Center (CIMMYT), the International Institute of Tropical Agriculture (IITA), and universities in Ghana and overseas.

17 percent of the total fte researchers in a 22-agency sample were female, ranging from 7 percent of those holding doctorate degrees, to 19 percent of those trained to the MSc level, and 27 percent of those trained to the BSc level. CRIG and the higher-education sector employed fewer female researchers relative to CSIR and the four other government agencies (Figure 4). The share of female researchers varied widely among CSIR institutes, ranging from 5 and 7 percent at SARI and SRI, respectively, to 29 percent at ARI, and 42 percent at FRI. The overall share of female researchers in the government sector increased from 9 percent in 1991 to 17 percent in 2001 (Roseboom and Pardey 1994), and in the higher-education sector, based on the three (of four) agencies for which 1991 data was available (UCC's Faculty of Agriculture and KNUST's Faculty of Agriculture and Institute of Renewable Natural Resources), the share of female researchers seemingly increased during 1991–2001 as well. The share of female researchers employed at UCC's Faculty of Agriculture, on the other hand, decreased from 21 percent in 1991 to 10 percent in 2001 (calculated from Roseboom and Pardey 1994).

Figure 4 Share of female researchers, 2001

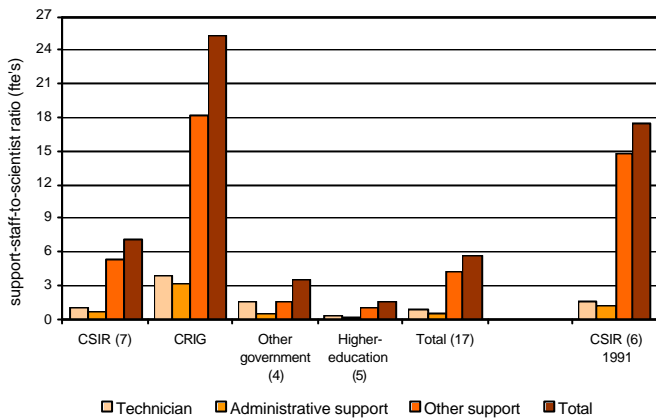


Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).

Note: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff.

In 2001, the average number of support staff per scientist in a 17-agency sample for which data were available was 5.7, comprising 0.9 technicians, 0.6 administrative personnel, and 4.2 other support staff such as laborers, guards, drivers and so on (Figure 5). CRIG had by far the highest ratio of support staff per scientist in 2001, at 25.3, but this is because many of the support staff are employed in production activities at the institute's plantation farms. CSIR's support staff per scientist ratio in 2001 was less than half the corresponding 1991 ratio, reflecting retrenchments of (mainly) other support staff combined with an increase of total researcher numbers in the 1990s. CRI has lost more support staff relative to the other CSIR agencies. Consistent with other national agricultural research agencies across Africa, this can be explained by efforts to increase efficiencies by rationalizing the number of support staff.

Figure 5 Support-staff-to-researcher ratios, 1991 and 2001



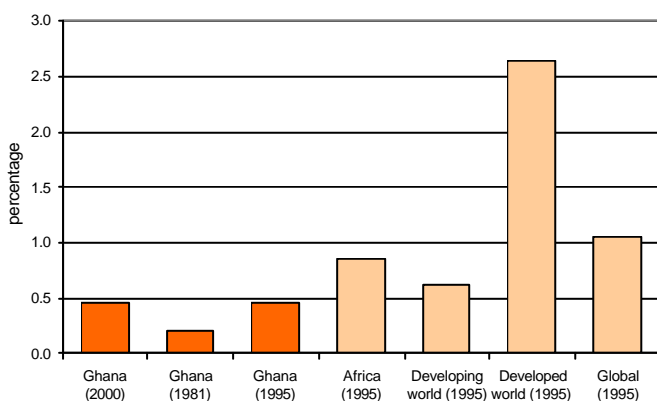
Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03).

Notes: Figures in parentheses indicate the number of agencies in each category. Data exclude expatriate staff. CSIR data for 1991 exclude OPRI, SARI and SRI. CSIR data for 2001 exclude OPRI and SARI.

Spending

Total public spending as a percentage of agricultural output (AgGDP) is a common research investment indicator to place a country's agricultural R&D spending in an internationally comparable context. In 2001, Ghana invested \$0.44 for every \$100 of agricultural output; which was slightly lower than the country's ratio six years earlier (0.47). Although Ghana's 2001 ratio is about half the 1995 average for Africa as a whole, at 0.85 percent, it represents a two-fold increase over the country's 1981 ratio of 0.21, at which time agricultural research expenditures were relatively low (Figure 6).

Figure 6 Ghana's public agricultural research intensity compared regionally and globally

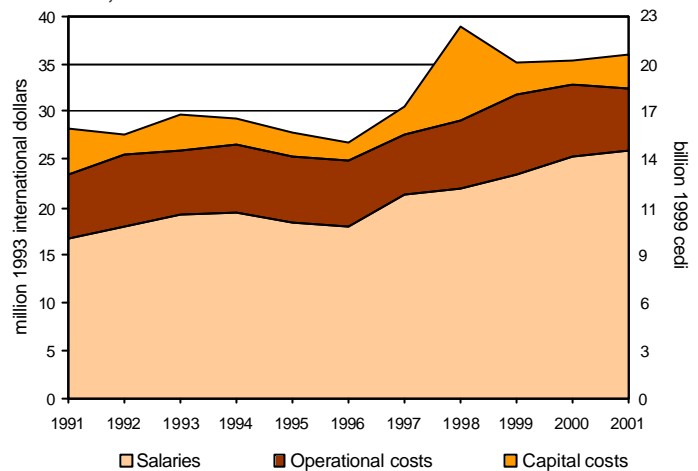


Sources: Ghana compiled from Figure 1b; AgGDP from World Bank (2003); other intensity ratios from Pardey and Beintema (2001).

CRI, with \$9.6 million in 2001, was by far the biggest spender of the 8 CSIR institutes for which detailed financial information was available. OPRI and FORIG followed with expenditures of \$4.7 and \$4.6 million, respectively. In comparison, CRIG's 2001 expenditures amounted to \$9.7 million. During 1991–2001, total salaries accounted for roughly

two-thirds of CSIR's spending on average, while the shares of operational and capital costs were 23 and 12 percent, respectively (Figure 7). Under NARP, various CSIR institutes, universities, and MOFA regional offices benefited from upgrades to research stations, laboratories, vehicles, libraries, and office and laboratory equipment. In addition to capital costs, NARP also funded certain operational costs under the Medium Term Action Plan (MTAP), which encompassed allocations for priority agricultural commodities (CSIR 2001). Capital and operational expenditures have been funded under AgSSIP since its inception in 2000, and more will be funded in the coming years. The 1998 peak in total capital expenditure resulted from FORIG's high capital investments during that particular year.

Figure 7 Cost-category shares in expenditures for eight CSIR institutes, 1991–2001



Source: Compiled by authors from ASTI survey data (IFPRI–ISNAR–ASARECA 2002–03).

Notes: Data include estimated salaries for expatriate staff (see Methodology on page 9).

FINANCING PUBLIC AGRICULTURAL R&D

Agricultural research in Ghana is largely funded by the national government, though loans from the World Bank and aid from other donors represent important contributions. The World Bank has provided loans to agricultural research in Ghana under two consecutive projects, NARP and AgSSIP, which are also funded by the government and other international donors. NARP had a total project cost of US\$26 million and ran from 1991 until 1999, encompassing all the CSIR, MOFA, and higher-education sector's agencies engaged in agricultural research, as well as farmer representatives. The main objectives of NARP were to enhance collaboration among the various participants in agricultural research, who had previously only worked independently of each other, and to rehabilitate the research infrastructure that had gradually deteriorated from 1970 to 1990 because of persistent underfunding and the ensuing exodus of large numbers of well-trained and experienced scientists. Local and foreign training of scientists, as well as a development of a library and information system were two key components of NARP (World Bank 2000).

AgSSIP is a three to five year rolling plan, launched in 2000 as part of the economywide "Vision 2020" plan that aims to reduce poverty and raise Ghana to middle-income level by

2020. AgSSIP's potential phasing is dependent on the available resources and the willingness of the implementing agencies to carry out the subprograms and projects assigned to them (MOFA 1999). The first three-year phase (2000–03) included various components supporting and strengthening the development of multiple and demand-driven agricultural services for rapid agricultural growth and poverty alleviation.⁹ Under AgSSIP, producers and exporters of crops such as oil palm and palm oil, fruits and vegetables, cotton, coffee, yams, and sheanut butter, along with agribusiness, will fund a growing share of the research costs for these commodities (World Bank 2000). Total agricultural research support for the first phase of AgSSIP was US\$15.4 million (World Bank 2000), including contributions from the Government of Ghana, the African Development Bank (ADB), the Canadian International Development Agency (CIDA), the Danish International Development Assistance (Danida), the British Department for International Development (DFID), the European Commission (EC) and the International Fund for Agricultural Development (IFAD). The agricultural research component had four main objectives: enhancing agricultural productivity and reducing poverty through the release of new technologies, promoting intensification of farming systems, increasing demand-driven research by involving farmers and other key stakeholders in the governance and financing of agricultural R&D, and improving the cost-effectiveness of research.

AgSSIP includes the establishment of a competitive agricultural research grant scheme (CARGS) that provides research funding based on the quality of research proposals. CARGS supports collaboration between research and nonresearch bodies in Ghana's private and nonprofit sectors, but also promotes international research cooperation (World Bank 2000). CRI, for example, noted that the fierce competition for grants since the introduction of CARGS has strengthened its linkages with FRI and KNUST. Depending on the success of the first phase of AgSSIP, larger components of the operating costs of core research programs may be allocated to CARGS in later phases. The ability of agricultural research staff to access grants through CARGS or secure external funding will gain importance in Ghana in the coming years (World Bank 2000), hopefully stimulating research excellence, as is the intent.

The savanna agricultural research program, supported by the German Agency for Technical Cooperation (GTZ), and the grains and legume improvement program, supported by CIDA, have also contributed to the revitalization of agricultural research in Ghana in the 1990s (World Bank 2000). Other bilateral and multilateral donors to government research agencies include Denmark, the European Union, France, Japan, the Netherlands, the United Kingdom, UNDP and the United States (Gage and Sarr 2001; CSIR 2003). Agricultural research at Ghana's universities is financed primarily by the government, although other donors including FAO, nongovernmental organizations, and foreign universities contribute to the higher-education sector's total research funding.

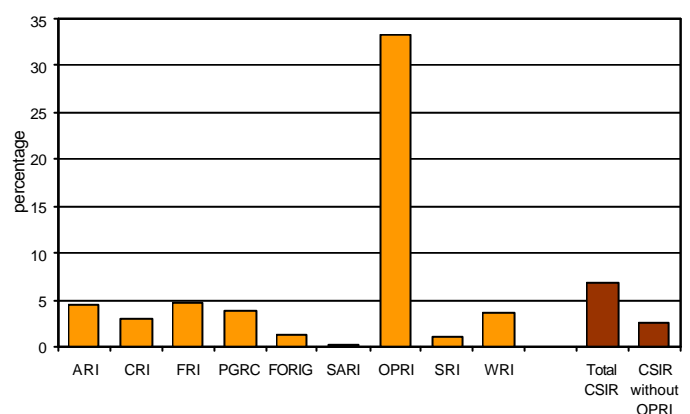
Commercialization of Research

In accordance with the target that CSIR agencies generate 30 percent of their funding from private sources by 2001, CSIR's institutes and centers were asked to develop business plans and create Business Development Units (BDUs) to assist them

achieving these targets (Adoum 1997). Commercialization areas were to include the sale of products, market research, training, and partnerships with entrepreneurs to exploit new technologies. The commercialization strategy is supported by many donors. GTZ, for example, recently ceased its 25-year financial support to SARI and is now assisting the institute by reinforcing its financial capacity and providing management training to develop skills in areas like project management, marketing, and contract negotiation (Armor 1997).

More generally, however, commercialization is limited to the sale of by-products from field stations, and as a result, an imbalance has resulted in the ability of the agencies to achieve their targets. In 2001, only 7 percent of the combined budget of the CSIR's nine agricultural research agencies is generated internally, and OPRI is the sole institute that has reached its 30 percent target in recent years (Figure 8). Excluding OPRI, only 3 percent of CSIR's agencies funding was internally generated. Commodity-based institutes whose mandate is food security, such as CRI, ARI, and SARI, are poorly placed to achieve the target given their focus is crops and livestock for smallfarmers who cannot afford to pay for the services and information these institutes supply. Achieving these targets is much easier for institutes like FORIG and OPRI, whose commodities supply important export value (Gage and Sarr 2001). Hence, although government funding was scheduled to be reduced in 2001, this did not occur. 2001 government funding levels for most CSIR institutes and centers changed little from those of 2000. After nearly seven years of these disappointing results, many CSIR agencies have yet to recruit marketing officers charged with commercialization issues, and some now say that sanctions and incentives must be introduced to stress the importance of commercialization, and a fair and transparent monitoring system is essential at this stage (Armor 1997; Gage and Sarr 2001).

Figure 8 Commercialization rate of CSIR agencies, 2001



Sources: Compiled by authors from ASTI survey data (IFPRI–ISNAR–CORAF/WECARD 2002–03); FORIG and SARI shares from Gage and Sarr (2001).

Currently all agricultural research, with the exception of activities related to cocoa, is funded by the Government of Ghana, donors, and self-funding by the respective agencies. For cocoa, producers apply a levy on the Freight on Board (FOB) price (World Bank 2000). CRIG has benefited from its association with COCOBOD and has been partially funded through this cocoa levy. CRIG also reported funding from the European Union Common Fund for Commodities and from

international cocoa and coffee organizations, and the Ghana Cocoa Marketing Board (Wayo Seini 2002). The World Bank's Cocoa Rehabilitation Project also financed some of CRIG's expenses. The aim of this project was the revitalization of Ghana's cocoa industry, which had lost ground because of poor prices, weak services (such as disease control and research), and inefficient input supply and marketing.

RESEARCH ORIENTATION

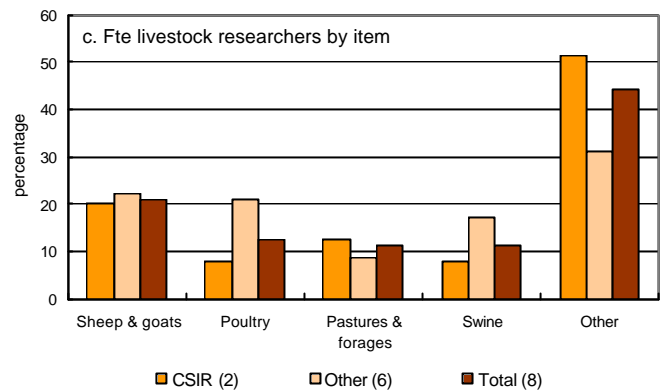
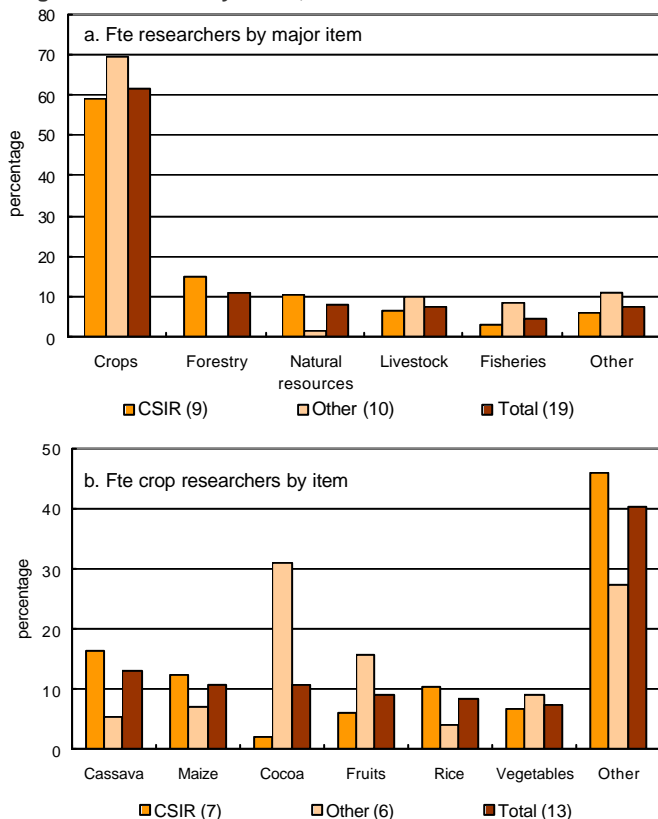
Commodity Focus

The allocation of resources among various lines of research is a significant policy decision; hence detailed information was collected on the number of fte researchers working in specific commodity and thematic areas.

In 2001, more than 60 percent of the 442 fte researchers in the 19-agency sample conducted crop research. Forestry research accounted for 11 percent of the total, natural resources for 8 percent, and livestock for 7 percent (Figure 9a). Compared with other regional government and higher-education agencies, CSIR researchers spent more time on forestry and natural resources research.

The major crops were cassava, maize, and cocoa, which each accounted for between 11 and 13 percent of all fte crop researchers in our sample. Other important crops included fruits, rice, and vegetables (Figure 9b). Most livestock researchers conducted research on sheep, goats, and poultry (Figure 9c).

Figure 9^{3/4} Commodity Focus, 2001



Source: Compiled by authors from ASTI survey data (IFPRI -ISNAR -CORAF/WECARD 2002-03).

Notes: Figures in parentheses indicate the number of agencies in each category. No information on commodity research focus was available for 10 higher-education agencies. Figure 9b includes agencies involved in crop research only; Figure 9c includes agencies involved in livestock research only.

Thematic Focus

In 2001, 18 percent of CSIR's researchers were working on crop genetic improvement, 13 percent on postharvest research, 9 percent on crop pest and disease control, and 9 percent on water research (Table 2). The remainder of CSIR's researchers focused on other crop research with only a small proportion working on research in livestock, soil, and other natural resources.

Table 2^{3/4} Thematic focus, 2001

	Numbers of researchers		Shares	
	CSIR (9)	Other (10)	CSIR (9)	Other (10)
	<i>(in fte's)</i>		<i>(percent)</i>	
Crop genetic improvement	59.5	14.3	18.4	12.1
Crop pest and disease control	29.2	15.9	9.0	13.5
Other crop	63.3	20.1	19.5	17.0
Livestock genetic improvement	8.2	2.2	2.5	1.8
Livestock pest and disease control	2.5	3.6	0.8	3.1
Other livestock	13.7	7.6	4.2	6.4
Soil	13.7	8.6	4.2	7.3
Water	27.7	0.4	8.6	0.4
Other natural resources	5.2	0.9	1.6	0.8
Postharvest	42.1	3.1	13.0	2.6
Other	58.7	41.4	18.1	35.0
Total	323.8	118.3	100	100

Source: Compiled by authors from ASTI survey data (IFPRI -ISNAR -CORAF/WECARD 2002-03).

Notes: Figures in parentheses indicate the number of agencies in each category. "Other" excludes the Faculty of Agriculture and IRNR, both under KNUST, and two departments under the Faculty of Science of UCC.

CONCLUSION

Agricultural research expenditures and funding increased marginally in Ghana throughout the 1990s. Like counterparts across much of Africa, agricultural R&D agencies in Ghana remained highly dependent on government and donor funding, with the World Bank's NARP and AgSSIP initiatives contributing greatly to the rehabilitation of Ghana's weakened agricultural research infrastructure. Most notable is the shift toward commercialization of agricultural research, heralded by the 1996 CSIR Act requiring that, by 2001, 30 percent of the agricultural research budgets of CSIR agencies be generated from private sources. Only one CSIR agency has met this target to date, and consequently the government has not reduced its funding to CSIR agencies as was scheduled to occur in 2001. It remains to be seen, however, whether the government and donors continue to support agencies that fail to meet their commercialization targets in the future, given the strong focus on commercialization under AgSSIP. Another issue that may require ongoing consideration is the imbalances in capacity of CSIR agencies to successfully generate revenues given some, like FORIG and OPRI have a strong commercial focus, while others, like CRI, ARI, and SARI, focus on broader social issues like food security.

NOTES

1. The authors are grateful to numerous colleagues in Ghana for their time and assistance with the data collection, and thank Nienke Beintema, Ivy Drafor, Han Roseboom, and Daniel Bruce Sarpong for their useful comments on drafts of this brief.
2. The 29-agency sample consisted of:
 - 14 government agencies/units: the Animal Research Institute (ARI), the Crops Research Institute (CRI), the Food Research Institute (FRI), the Plant Genetic Resources Centre (PGRC), the Forestry Research Institute of Ghana (FORIG), the Savanna Agricultural Research Institute (SARI), the Oil Palm Research Institute (OPRI), the Soil Research Institute (SRI), the Water Research Institute (WRI), the Cocoa Research Institute of Ghana (CRIG), the Biotechnology and Nuclear Agricultural Research Institute (BNARI), the Agricultural Engineering Services Directorate (AESD), the Animal Production Directorate (APD) and the Marine Fisheries Research Division (MFRD); and
 - 15 higher-education agencies: six entities of the University of Ghana (UG)—the Faculty of Agriculture, the Department of Botany, the Department of Nutrition and Food Science, and the Department of Zoology of the Faculty of Science, the Volta Basin Research Project (VBRP), the Institute of Statistical, Social and Economic Research (ISSER); three entities of the Kwame Nkrumah University of Science and Technology (KNUST)—the Faculty of Agriculture, the Department of Biological Sciences of the Faculty of Science and the Institute of Renewable Natural Resources (IRNR); four entities of the University of Cape Coast (UCC)—the Department of Botany and the Department of Zoology of the Faculty of Science, the School of Agriculture (SoA) and the Centre for Development Studies (CDS); the Faculty of Agriculture of the University of Development Studies (UDS); and the College of Agriculture Education (CAE) of the University College of Education of Winneba (UCEW).
3. Unless otherwise stated, all data on research expenditures are reported in 1993 international dollars or in 1999 Ghanaian cedis.
4. Unless otherwise stated, CSIR refers to the nine institutes that conduct agricultural research. The remaining four CSIR institutes that are not involved in agricultural research are the Science and Technology Policy Research Institute (STEPRI), the Institute for Scientific and Technological Information (INSTI), the Building and Road Research Institute (BRR) and the Institute of Industrial Research (IIR).
5. WRI was established in 2000 through a merger of CSIR's Institute of Aquatic Biology (IAB) and the Water Resources Research Institute (WRRI).
6. UG, KNUST, UCC, and UDS all have autonomous status granted by the Ghanaian government, while UCEW is affiliated with UCC (ACU 2002).
7. Data are calculated as least square growth rates.
8. Although precise figures are not available, it is estimated that between 1975 and 1983 approximately 25 percent of researchers employed at agricultural research institutes in Ghana left for employment abroad, notably to Nigeria, Botswana, Libya, Europe, and North America (Tabor et al. 1992).
9. During Phase II of AgSSIP (2004-2006), the restructuring of the first phase will be expanded and consolidated. MOFA will be restructured, district assemblies will be managing extension services, demand-driven research and extension systems will be created, and farmer-based organizations will be promoted. In Phase III (2007-2009), progress will continue through the establishment of a pluralistic, demand-driven system of agricultural technology generation and diffusion. The basis of the system will be public- and private sector cooperation and outsourcing of research by private enterprises to the agricultural research agencies (World Bank 2000).

METHODOLOGY

- Most of the data in this brief are taken from unpublished surveys (IFPRI, ISNAR, and CORAF/WECARD 2002-03), and ACU (various years).
- The data were compiled using internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1994; UNESCO 1984). We grouped estimates using three major institutional categories—government agencies, higher-education agencies, and business enterprises, the latter comprising the subcategories private enterprises and nonprofit institutions. We defined public agricultural research to include government agencies, higher-education agencies, and nonprofit institutions, thereby excluding private enterprises. Private research includes research performed by private-for-profit enterprises developing pre, on, and postfarm technologies related to agriculture.
- Agricultural research includes crops, livestock, forestry, and fisheries research plus agriculturally related natural resources research, all measured on a performer basis.
- Financial data were converted to 1993 international dollars by deflating current local currency units with a Ghanaian GDP deflator of base year 1993 and then converting to U.S. dollars with a 1993 purchasing power parity (PPP) index, both taken from World Bank (2003). PPP's are synthetic exchange rates used to reflect the purchasing power of currencies, typically comparing prices among a broader range of goods and services than conventional exchange rates.
- The salaries and living expenses of many expatriate researchers working on donor-supported projects are paid directly by the donor agency and are often excluded in the financial reports of the agricultural R&D agencies. These *implicit* costs have been estimated using the average cost per researcher in 1985 to be \$160,000 1993 international dollars and backcasting this figure using the rate of change in real personnel costs per full-time researcher in the US state agricultural experiment station system. This extrapolation procedure has the assumption that the personnel-cost trend for US researchers is a reasonable proxy of the trend in real costs of internationally recruited staff in the agricultural R&D agencies.

See the ASTI website (<http://www.ASTI.cgiar.org>) for more details on methodology.

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ABOUT THE AUTHORS

Gert-Jan Stads <g.stads@cgiar.org> is a project officer at ISNAR.

Joseph O. Gogo <stepri@africaonline.com.gh> is the director of Ghana's Science and Technology Policy Research Institute (STEPRI).

CONTACT ASTI INITIATIVE <http://www.asti.cgiar.org>

Nienke Beintema, Project Coordinator <ASTI@cgiar.org>

International Food Policy Research Institute (IFPRI)

2033 K Street, N.W.
Washington, D.C. 20006 U.S.A.
Phone +1 (202) 862-5600
Fax +1 (202) 467-4439

<http://www.ifpri.cgiar.org>

International Service for National Agricultural Research (ISNAR)

P.O. Box 93375
2509 AJ The Hague, The Netherlands
Phone +31 (70) 349-6100
Fax +31 (70) 381-9677

<http://www.isnar.cgiar.org>