ASSESMENT OF AGRICULTURAL RESEARCH CAPACITIES IN GHANA:

THE CASE OF COUNCIL FOR SCIENCTIFIC AND INDUSTRIAL RESEARCH (CSIR)

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ASTI Agricultural Science & Technology Indicators
FACILITATED BY IFPRI

CORAF/WECARD

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List of Acronyms

ARI	Animal Research Institute
ASTI	Agricultural Science & Technology Indicators
BNARI	Biotechnology Nuclear Agricultural Research Institute
BRRI	Building and Road Research Institute
CARGS	Competitive Agricultural Research Grant Scheme
CORAF/WECARD	West and Central African Council for Agricultural Research and Development
CRI	Crops Research Institute
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research
CSPRM	Centre for Scientific Research into Plant Medicine
EPA	Environmental Protection Agency
FORIG	Forestry Research Institute of Ghana
FRI	Food Research Institute
FTE	full-time equivalent
GAEC	Ghana Atomic Energy Commission
IFPRI	International Food Policy Research Institute
INSTI	Institute for Scientific and Technological Information
MESTI	Ministry of Environment, Science, Technology and Innovation
MFRD	Marine Fisheries Research Division
MOFA	Ministry of Food and Agriculture
NARS	National Agricultural Research System
NCC	National Coordinating Committee
NGO	nongovernmental organization
OPRI	Oil Palm Research Institute
PGRRI	Plant Genetic Resources Research Institute
PPP	purchasing power parity
R&D	research and development
RELCs	Research-Extension-Farmer Linkage Committees
SARI	Savanna Agricultural Research Institute
SRI	Soil Research Institute
STEPRI	Science and Technology Policy Research Institute
T&CPD	Town and Country Planning Department
WAAPP	West Africa Agricultural Productivity Program
WRI	Water Research Institute

INTRODUCTION

The Economic Community of West African States (ECOWAS) Regional Research Policy seeks to harmonize scientific research and create research synergies in the region. One of the main constraints the community is facing is access to up-to-date and high-quality data, on the scientific research capacity in its member countries. Given the importance of agriculture in the region, ECOWAS has requested the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) to carry out an in-depth assessment of the critical issues surrounding the human, financial, and institutional capacities in West African agricultural research. Such an assessment is key to the development of national and regional policy recommendations that will ultimately feed into a regional agricultural research strategy for West Africa. To accomplish this assessment, CORAF/WECARD has solicited the support of the Agricultural Science and Technology Indicators (ASTI) program of the International Food Policy Research Institute (IFPRI).

This assessment is conducted in three phases:

- As part of Phase I (2012–2013) ASTI/IFPRI, CORAF/WECARD, and national partners, launched a survey in 21 West and Central African countries collecting detailed staffing and financial information from a complete set of government, higher education, nonprofit, and private-sector agencies involved in agricultural research and development (R&D). The outputs of this survey can be accessed on the ASTI website: http://www.asti.cgiar.org.
- During Phase II (2013–2014) a more in-depth assessment of the critical issues surrounding West African agricultural R&D was conducted in six ECOWAS countries: Benin, Burkina Faso, Ghana, Senegal, Sierra Leone, and Togo. The assessment included a quantitative survey collecting information on human and financial resources, R&D infrastructure, and R&D outputs; a series of face-to-face interviews with selected research and managerial staff; and a staff motivation survey distributed to a selected group of researchers and managerial staff. The outcomes of this in-depth assessment have been summarized in a series of country reports, as well as a regional report synthesizing the critical challenges faced by West African agricultural R&D institutes.
- During Phase III (2014) the outputs of Phase II will be translated into policy recommendations that will feed into the development of the regional agricultural research policy strategy and that will be presented at various stakeholder events.

The current report is one of the outputs of Phase II. It gives an overview of the critical issues surrounding the human, financial, and institutional capacity of the Council for Scientific and Industrial Research (CSIR) and provides a set of policy options that could help address some of these most pressing challenges.

OVERVIEW OF AGRICULTURAL R&D IN GHANA

Agricultural research is fundamental to enhancing Ghana's agricultural productivity. Toward this end, the country has created a National Agricultural Research System (NARS) that spans research institutes, tertiary educational institutions, and other organizations. How effective the NARS has been in enhancing agricultural practices and productivity in Ghana is a fundamental question of concern to all stakeholders, including policymakers, farmers, researchers, and development workers.

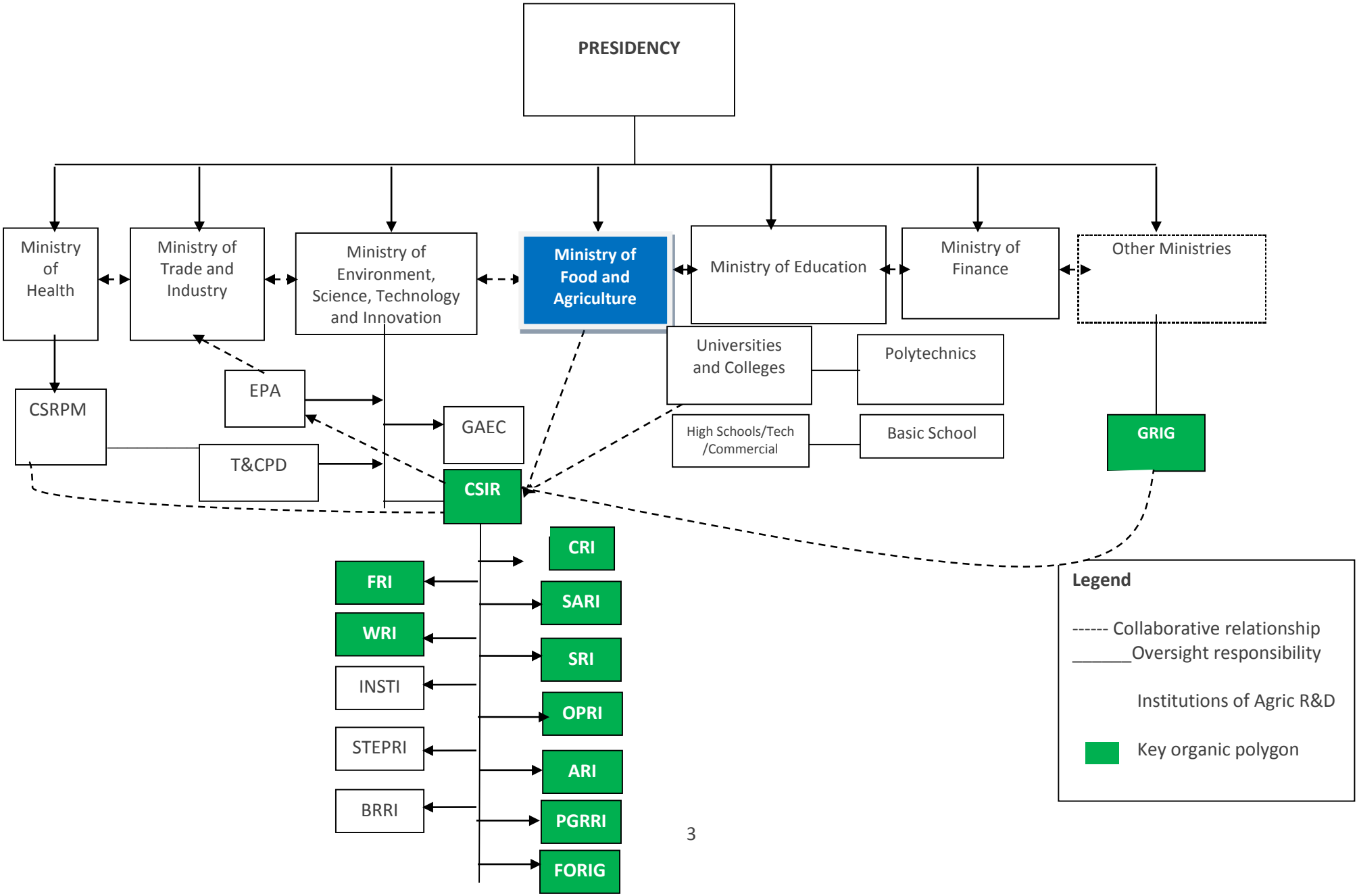
Ghana's main agency is CSIR and its 13 institutes, of which 10 are engaged in agricultural and related research activities. Other non-CSIR research institutions include the Cocoa Research Institute of Ghana (CRIG) and the Marine Fisheries Research Division (MFRD). CRIG, in particular, has a long history of research on tree crops of economic importance to Ghana—cocoa, coffee, kola and cashew. These research institutions drive the formal public-sector innovation in agriculture in Ghana.

Moreover, R&D forms an integral part of the core activity in tertiary education of the agricultural faculties of public universities, such as the University of Ghana, Kwame Nkrumah University of Science and Technology, the University of Cape Coast, and the University for Development Studies. The research work of the tertiary educational institutions complements the work conducted in CSIR and the other non-CSIR institutions generally.

CSIR is operating fairly autonomously under the Ministry of Environment, Science, Technology, and Innovation (MESTI). A similar structure exists within the other research institutions. CRIG falls under the Ministry of Finance; the Biotechnology Nuclear Agricultural Research Institute (BNARI), under the Ghana Atomic Energy Commission (GAEC), is also under MESTI; MFRD is under the Ministry of Food and Agriculture (MOFA); and the public universities are under the Ministry of Education. Figure 1 illustrates the institutions and their interrelationships.

The configuration of the NARS has remained virtually the same over the past two decades, with MOFA having the overall responsibility for agricultural policy formulation and oversight of policy implementation. Despite the diversity of ministries involved in agricultural R&D activities in Ghana, there is a strong connection between MOFA and the other ministries.

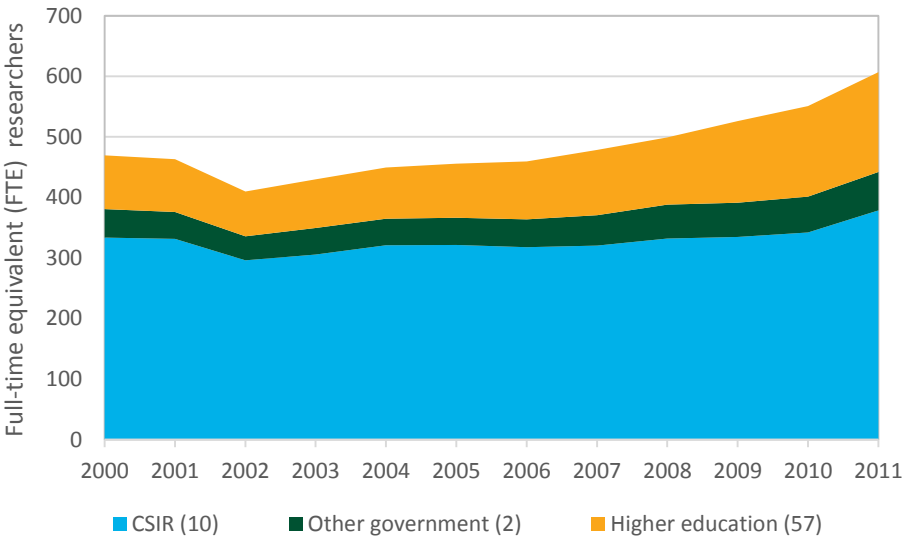
Figure 1. Institutional structure of R&D in Ghana



Contributions of Researchers and Investment in Agricultural Research

The contribution of agricultural researchers to national development through agricultural R&D is critical, as it is linked with agricultural output and productivity. From 2000 to 2011, the number of full-time equivalent (FTE) researchers in Ghana steadily increased, from 470 in 2000 to 607 in 2011, though there was a slight decline in 2002 (Figure 2). CSIR is the dominant contributor to the total number of agricultural researchers, while the higher education institutions and other non-CSIR government research institutions are complementary contributors.

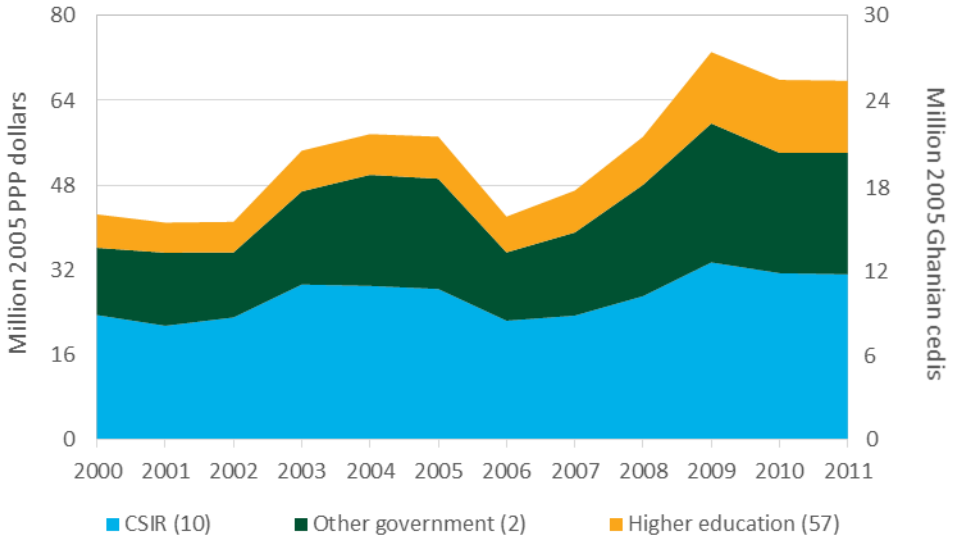
Figure 2 FTE agricultural researchers by institutional category, 2000–2011



Source: ASTI/IFPRI-STEPRI 2012–13.

Similar to the researcher trend, agricultural research spending has increased overall from 15.8 million 2005 cedis in 2000 to 25.1 million 2005 cedis in 2011 (Figure 3). Within the same period, the spending trend has shown an erratic pattern, with a sharp decline in 2006 followed by a steady increase until 2009, when spending declined. The rise and fall in the pattern of spending could be attributed to the high dependence on donor funding for agricultural research in Ghana in the face of declining government support for such research.

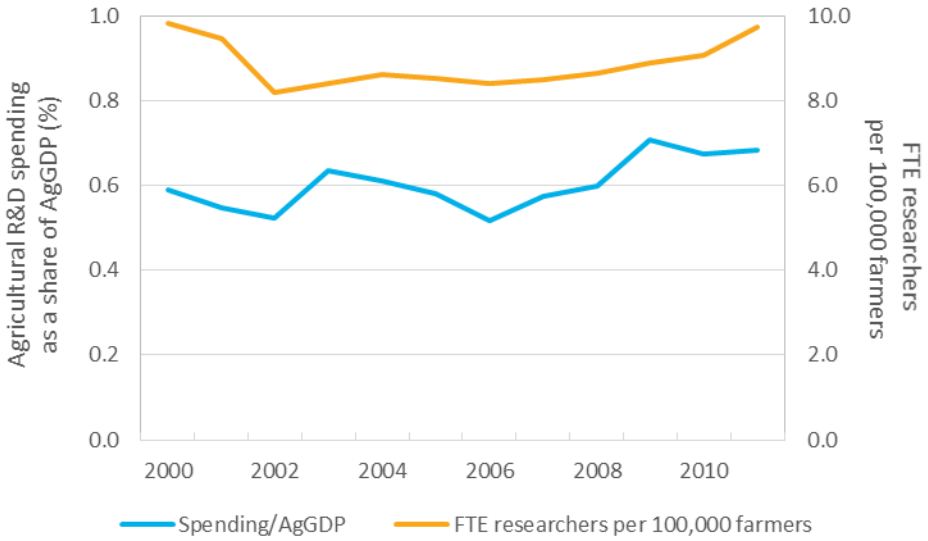
Figure 3. Agricultural research spending by institutional category, 2000–2011



Source: ASTI/IFPRI-STEPRI 2012–13.

The agricultural research intensity ratios between 2000 and 2011 show an average of 0.60 percent agricultural spending to agricultural gross domestic product (GDP); over time the intensity increased slightly from 0.59 in 2000 to 0.68 in 2011. The FTE researchers per 100,000 farmers average was 8.85 for the same period (Figure 4).

Figure 4. Agricultural research intensity ratios, 2000–2011



Source: ASTI/IFPRI-STEPRI 2012–13.

Although the increase in both ratios since 2000 implies that the investment in agricultural research is appreciable, the extent of researchers' access to additional funding is very limited going by the percentage agricultural spending of agricultural GDP. There is need to increase funding levels to boost agricultural R&D. Apart from this, there is need to enhance the human resource investment in agricultural research to improve the number of researchers FTE per 100,000 farmers.

THE STRUCTURE AND ORGANIZATION OF CSIR

CSIR Mandate and Structure

Established in 1968, CSIR is the largest and main R&D agency in Ghana. The Council for Scientific and Industrial Research Act, 1996, Act 521–the law that created CSIR–categorically stipulates 14 functions for the institution, including:

- To pursue the implementation of government policies on scientific research and development.
- To encourage in the national interest scientific and industrial research of importance for development of agriculture, health, medicine, environment, technology, and other service sectors, and to this end, to encourage close linkages with the productive sectors of the economy.
- To review, monitor, and periodically evaluate the work of the institutes administered by the CSIR, to ensure that research being carried out by the institutes directly benefits identified sectors of the economy and is within national priorities.
- To encourage and promote the commercialization of research results (Government of Ghana 1996).

The 10 CSIR institutes involved in agricultural or related research activities are:

- Animal Research Institute (ARI)
- Crops Research Institute (CRI)
- Soil Research Institute (SRI)
- Oil Palm Research Institute (OPRI)
- Food Research Institute (FRI)
- Forestry Research Institute of Ghana (FORIG)
- Plant Genetic Resources Research Institute (PGRRI)
- Savanna Agricultural Research Institute (SARI)
- Water Research Institute (WRI)
- Science and Technology Policy Research Institute (STEPRI)

Both STEPRI and WRI have mandates that are broader than agriculture.

CSIR Governance and Collaboration

Though CSIR is a research establishment, scientists are considered to be public servants, and are compensated for their work by the government. CSIR is currently operating fairly autonomously under MESTI.

As a corporate body, CSIR is governed by a council, and management is headed by the Director General, who is supported by a Deputy Director General and directors of finance, audit, administration, and commercialization. This corporate management body oversees the daily running of CSIR. At the institute level, each institute has a Management Board and is headed by a director who is responsible for the institute's daily operations. Planning at the corporate level has been limited and needs to be improved to give strategic direction to the institutes. CSIR's most current strategic plan was prepared for the period 2005–2009 (CSIR 2005). The preparation of updated and more regular strategic plans and with their effective implementation are expected to make CSIR more dynamic.

Research activities are also planned at the institute level, with each institute developing a five-year strategic plan with inputs from key stakeholders and actors, including policymakers, sector

ministries, and the private sector.[1] These strategic plans are linked to the CSIR's broader planning. Within the plans, priorities are set with stakeholders, and are normally dictated by national priorities as captured in the national development agenda, donor programs, and general issues affecting Ghanaians. These strategic plans also are in need of updating.

There is collaboration among the CSIR institutes, especially in the context of some of the funding frameworks, such as the West Africa Agricultural Productivity Program (WAAPP) and within other projects. For example, STEPRI collaborates with WRI on a project on promoting rainwater harvesting systems for households and institutions, and with seven other institutes on a technology transfer project. However, such collaboration continues to be limited and needs further enhancement, especially given the current emphasis that institutes need to generate their own funding internally. With greater collaboration, the institutes can attract more projects and have greater impact.

The R&D connections between CSIR and other ministries and agencies in Ghana are mainly collaborative. With regard to agricultural research, there is some collaboration between the institutes and MESTI and MOFA. In addition, officials of MOFA are serving on management boards of CSIR institutes, where they can provide advice on the institutes' operations in line with national agricultural policies. There is also some collaboration with the universities, where senior researchers teach part time and supervise students' project work. In the same vein, some students from the universities have practical internship at all CSIR institutes as part of their degree programs.

So long as these collaborative connections are sustained, R&D at CSIR has the potential to enhance the impact of research in the NARS. Otherwise, institutes working in their discrete functional compartments without extensive collaboration create less impact in national R&D. Furthermore, the inter-institutional collaboration and linkages need to be improved for better delivery on the R&D mandates.

The institutional linkages to the users are even more important. In 1994, MOFA and CSIR established the Research-Extension-Farmer Linkage Committees (RELCs) to serve as an interface between the NARS and the National Agricultural Extension System, with the aim of bridging the gap between research, extension, farmers, and agribusiness. In concept, the RELCs involve farmers in identifying problems needing research solutions, and provide research results that enhance farming practices and productivity. However, the RELCs perform directing or steering functions—not implementing functions (CSIR and MOFA 2013a). Therefore, that dynamic interface for ensuring constant transfer of innovations from research into farming is absent.

RESEARCHERS CAPACITY

Comparison of the CSIR's Research and Support Staff

The institutes employ large workforces, mainly because of the large land acreages they need to have to carry out their research and engage with farmers. For example, CRI has 758 employees, with a core research staff of 77, which is the highest for any institute; and SARI, located in the heart of the savanna grassland in the north of Ghana, has the next-highest, with 404 employees and 32 core researchers. The high numbers of the total workforce create a condition for undesirable ratios of researchers to non-researchers in the agricultural institutes. CRI has a ratio of 1:8.8. SARI has a ratio of 1:1.6, and SRI has a ratio of 1:9.9. A significant segment of the support staff are farmhands and junior staff working on the institutes' farms.

There is a persistent question of whether these ratios can be reduced, which should be possible with significant infusion of funding for farm machinery. However, the overriding issue is whether the

[1] This point was made by all the directors who were interviewed during the study.

prevailing staffing situation enables the institutes to deliver on their mandates, given the present and emerging challenges. Rather than numbers, effective staffing should focus on the capability to deliver needed products and services that will have a significant positive impact on meeting national development goals.

Comparison of Expertise within the CSIR's Research Staff

The diversity of the mandates also requires a diversity of expertise in disciplines and research skills. The agricultural R&D human resource capacity in Ghana has generally shown some growth over the years, albeit not dramatically. As of 2012, the CSIR employed 375 agricultural researchers in various agricultural specialties, including agricultural economics, agronomy, animal sciences, entomology molecular biology, and soil science (Table 1).

Table 1. Distribution of CSIR agricultural researchers by degree and discipline, 2012

Specialization	PhD	MSc	BSc	Total	Share
Agricultural economics	1	10	4	15	4
Agronomy	7	15	2	24	6
Animal and livestock sciences (including veterinary medicine)	4	12	0	16	4
Biodiversity conservation	3	6	0	9	2
Crop sciences (including horticulture)	5	19	1	25	7
Ecology	4	4	0	8	2
Entomology	10	11	0	21	6
Extension and education/agriculture technology	0	5	1	6	2
Fisheries and aquatic resources	1	7	0	8	2
Food sciences and nutrition	10	36	0	46	12
Forestry and agroforestry	3	3	1	7	2
Molecular biology (applied to plant/animal breeding)	8	14	1	23	6
Natural resource management	2	2	0	4	1
Soil sciences	15	22	2	39	10
Water and irrigation sciences	6	8	0	14	4
Pathology	3	6	0	9	2
Plant breeding	7	6	0	13	3
Social sciences	2	19	4	25	7
Other	17	42	4	63	17
Total	**108**	**247**	**20**	**375**	**100**

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

Of the total number of researchers, 29 percent held PhD degrees, 66 percent MSc degrees, and only 5 percent BSc degrees. The low BSc percentage share overall is well in line with CSIR's current policy, which requires a minimum of an MSc to qualify for research staff. However, in the past, BSc staff members were employed as Assistant Research Officers. The crucial issue with regard to staff specialization is that the number of PhD research staff is still rather low. At least 50 percent of the staff should be trained to the PhD level, where researchers are sufficiently trained to confidently initiate or take control of research projects. Thus, obtaining a PhD has become an important requirement for promotion within CSIR, as seen by the emphasis on PhD training.

Attrition within the CSIR's Research Staff

During 2008–2012, close to one half of all training approved for researchers was for PhD training (Table 2).

Table 2. Number of CSIR researchers who received training, 2008–2012

Type and place of training	2008	2009	2010	2011	2012	Total
PhD						
In-country	4	2	5	5	8	24
In other African country	0	1	1	1	1	4
In other developing country	0	2	2	2	5	11
In high-income country	5	7	7	7	6	32
Total	**9**	**12**	**15**	**15**	**20**	**71**
MSc						
In-country	3	4	9	3	10	29
In other African country	0	0	0	0	1	1
In other developing country	0	0	0	0	0	0
In high-income country	2	0	4	2	5	13
Total	**5**	**4**	**13**	**5**	**16**	**43**
BSc						
In-country	4	9	1	3	12	29
In other African country	0	0	0	0	0	0
In other developing country	0	0	0	0	0	0
In high-income country	0	0	0	0	0	0
Total	**4**	**9**	**1**	**3**	**12**	**29**
Short-term training						
In-country	5	3	9	10	0	27
In other African country	0	1	1	0	0	2
In other developing country	0	0	0	0	0	0
In high-income country	0	1	0	0	6	7
Total	**5**	**5**	**10**	**10**	**6**	**36**

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

It was only in 2010 when MSc-level training received similar attention. This is justified also in view of staff departures from CSIR through retirement, resignations, and death. Institutional support for academic training toward obtaining degrees underscores the value placed on higher education in Ghana. In the specific case of the CSIR, PhD training is the most desirable. Thus between 2008 and 2012, 63 researchers departed from the CSIR, of whom about 65 percent were PhD holders (Table 3).

Table 3. Number of researcher departure and reasons for departure, 2008–2012

Researchers	2008	2009	2010	2011	2012	Total
By gender						
Female	1	1	0	1	2	5
Male	5	10	14	16	13	58
Total	**6**	**11**	**14**	**17**	**15**	**63**
By degree						
PhD	4	6	10	12	8	40
MSc	2	5	4	4	6	21
BSc	0	0	0	0	0	0
By age group						
40 years or younger	0	1	1	3	0	5
41–50 years	0	2	3	3	3	11
51–60 years	3	7	6	9	5	30
61 years or older	2	0	2	2	4	10
Reason for departure						
Retirement	5	1	4	8	7	25
Promotion to other government department	0	0	0	0	0	0
Transfer to other government department	0	0	0	0	0	0
Resignation	1	6	4	3	4	18
Dismissal	0	0	0	0	0	0
Death	0	0	1	1	2	4
Other	0	4	5	5	2	16
Total	6	11	14	17	15	63

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

The reasons for the departures of researchers included retirement, resignations, and promotion to other government positions. Apparently, many of the researchers who had no PhD degrees when they were recruited by the CSIR institutes often managed to obtain their PhD degree by the time of their departure. This is also evident when comparing the educational levels of researchers recruited with those departing CSIR.

One of the important policies the government implemented to curb staff turnover at CSIR is the "Single Spine Pay Policy," which became effective in January 2010. The policy is primarily aimed at compensating workers on the basis of key job characteristics, which are broadly categorized into knowledge and skills, responsibility, work environment, and effort (Fair Wages and Salary Commission, undated). The staff of CSIR began enjoying the implementation of the policy in 2012. The delay in application of the pay policy in CSIR was not an isolated case. The implementation process at some other public institutions also took a long time due to stringent bureaucracies. Generally, the policy's implementation addressed most of the salary-related expectations of the researchers and placed them on a par with their counterparts in the universities. However, support staff did not experience any pronounced rise in their salaries; therefore, the gap between the research staff and the support staff has widened significantly.

The senior-most researchers—the principal research scientists and the chief research scientists—are mentors in many cases to younger researchers. They mentor them mainly through project implementation in their respective institutes. However, the most experienced researchers with PhDs are on the verge of leaving CSIR—about 60 percent of them are 50 years or older. Only a few return to CSIR as contractors. Therefore, much of the mentoring work can only occur during these senior researchers' active working years.

Recruitment within the CSIR

CSIR's recruitment policy mainly emphasizes qualification in the requisite discipline, with a preferable number of years of work experience. Age is considered, with advertised positions often limited to candidates no older than 40 years. During 2008–2012, 86 percent of researchers recruited were 40 years old or younger (Table 4).

With about 66 percent of researchers having MSc degrees, the need for intensifying human resource development to ensure the highest degree of researcher training is apparent. Agricultural researchers at CSIR are widely distributed among the various agricultural specialties. CSIR-CRI has the majority of researchers (21 percent), while CSIR-STEPRI has the minority (3 percent). Soil science has the highest number of overall PhD holders (4 percent), while food science and nutrition has the highest number of MSc holders (10 percent). Such specialties as plant pathology, plant breeding, biotechnology, nematology, seed science technology, virology, crop physiology, and agriculture engineering collectively contributed 33 percent of the total agricultural research staff in the CSIR, of which 9 percent, 21 percent, and 2 percent are PhD, MSc, and BSc holders, respectively. Specialties are generally in consonance with the institutes' mandates; since STEPRI has a multidisciplinary mandate, it has only a few researchers in agricultural science.

Moreover, researchers in certain disciplines are inadequate.[2] For example, ARI, specifically in the Animal Health and Food Safety Division, needs veterinarians who are qualified to conduct research and lead in technology development, such as developing vaccines for preventing animal diseases. FORIG needs specialized engineers capable of leading research in the use of wood products for constructing buildings and bridges. And OPRI has gaps in expertise in such areas as biotechnology, plant pathology and plant breeding.

Table 4. Number of newly recruited CSIR researchers, 2012

Researchers	2008	2009	2010	2011	2012	Total
By gender						
Female	1	3	2	6	8	20
Male	6	20	12	15	27	80
Total	**7**	**23**	**14**	**21**	**35**	**100**
By degree						
PhD	5	5	2	0	9	21
MSc	2	9	9	12	24	56
BSc	0	5	3	1	0	9
By age group						
40 years or younger	2	15	9	13	20	59
41–50 years	1	0	4	0	4	9

[2] This was revealed in the interviews with the directors of the institutes.

Researchers	2008	2009	2010	2011	2012	Total
51–60 years	0	0	0	0	0	0
61 years or older	0	0	0	0	0	0
Area of specialization						
Agricultural economics	0	1	0	0	3	4
Agronomy	0	4	0	2	1	7
Animal and livestock sciences (incl. veterinary medicine)	1	1	1	1	3	7
Biodiversity conservation	0	3	0	0	0	3
Crop sciences (including horticulture)	0	0	0	2	1	3
Ecology	0	2	0	0	0	2
Entomology	0	0	2	0	1	3
Extension and education	0	0	0	0	0	0
Fisheries and aquatic resources	0	0	0	0	0	0
Food sciences and nutrition	1	0	5	0	4	10
Forestry and agroforestry	0	0	0	1	0	1
Molecular biology (applied to plant/animal breeding)	0	4	0	6	3	13
Natural resource management	0	0	1	0	0	1
Soil sciences	0	0	1	0	0	1
Water and irrigation sciences	0	0	0	1	0	1
Pathology	0	0	0	0	1	1
Plant pathology	0	0	0	0	1	1
Social sciences	0	0	0	0	0	0
Other	5	9	5	10	12	41
TOTAL	**7**	**24**	**15**	**23**	**30**	**99**

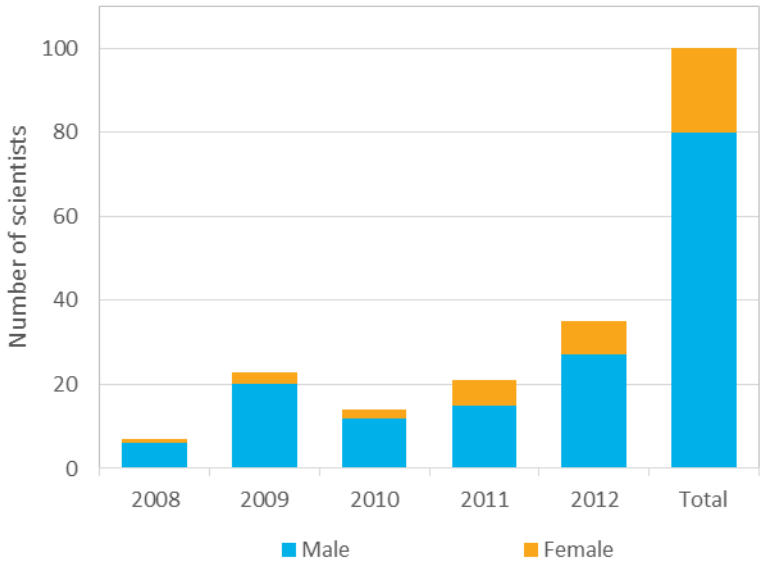
Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

CSIR has taken some initiatives to address these human resource challenges. For example, some projects are formulated with capacity building being a key component. In some cases, recruitment efforts continue, despite a general ban on employment in the public sector. By and large, the award of study leave with pay in CSIR provides the incentive for the staff to look for their own training opportunities and specialize to fill some of the gaps in expertise.

Filling gaps in the broad human resource tableau also relates to efforts to ensure a balance between departures from CSIR and recruitment. However, the numbers coming in are primarily MSc holders, whereas the departures are primarily PhD holders. This finding underscores the point that researchers usually build up their capabilities by the time they depart.

Another recruitment concern is the gender considerations that come into play. In principle, there is no gender bias in recruitment at CSIR. In fact, some advertisements actually state that women are encouraged to apply for the advertised positions. However, female researchers recruited into CSIR constituted less than 20 percent (Figure 5).

Figure 5. CSIR recruitment by gender



Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

A major cause of the gender disparity stems from the qualification requirement, or rather the educational level, and the disciplines. There are fewer female science graduates, especially at the higher degrees of physical and applied sciences. Climbing the ladder professionally in research—obtaining a PhD and conducting research to produce technologies and publish findings—can be demanding for many female scientists, who are mothers and wives as well as researchers (Obeng 2008). Though some women succeed, they are very few.[3] As a result female researchers are underrepresented in CSIR, though the opportunities for recruitment are generally available.

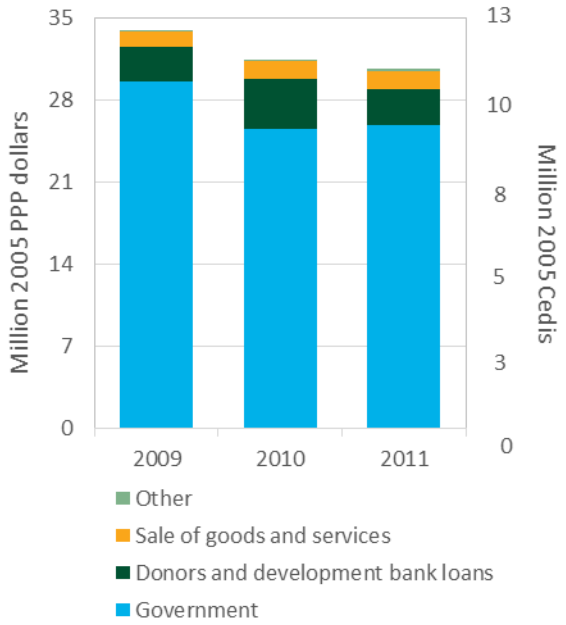
On the whole, the salient points of the analysis of CSIR's human resources relate to the disciplinary diversity of the research staff. Although the mix of skills is sufficient to address institutional mandates, gaps exist in research specialties, and the available research staff needs upgrading. Training to the PhD level is a priority not only for the institutes, but also for the individual researchers who need to progress to the highest point of their achievement.

[3] Currently the Deputy Director-General of the CSIR is a woman.

FINANCIAL RESOURCES AND EXPENDITURES

Finance is the most pressing challenge for research institutes in Ghana.[4] The three main sources of R&D financing are government grants; funding from donor agencies and foreign collaborators; and internally generated funds (Figure 6).

Figure 6. CSIR funding sources, 2009–2011



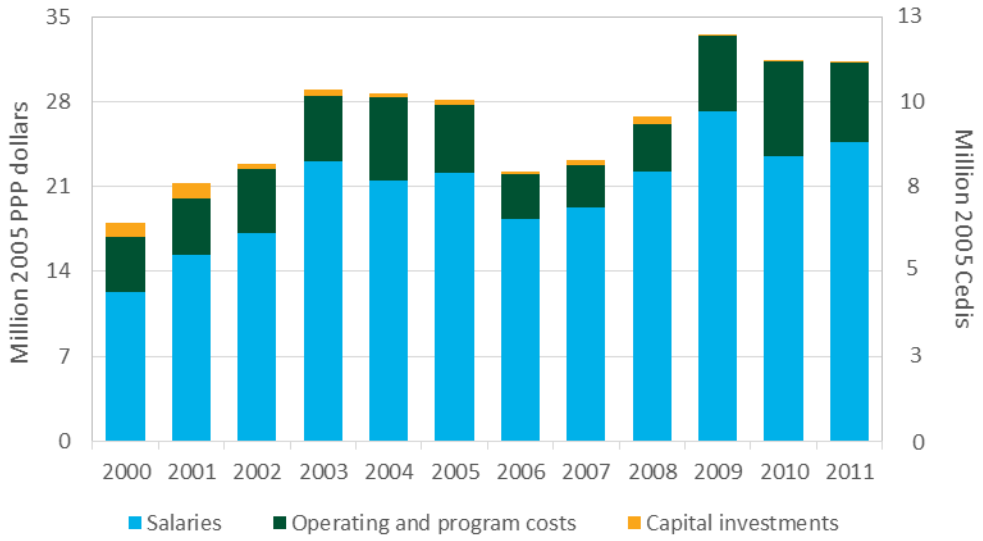
Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

Conventionally, the government is the dominant source of funding, because the CSIR institutes are public entities that need to be maintained with public funding. However, the emerging trend is that government is attempting to move away from assuming the primary responsibility of financing these research institutes. This is reflected in the drop in the level of funding, when adjusted for inflation, from 2009 to 2010 and 2011. The government still provides CSIR with funding for salaries, general goods and services, and investment (Figure 7).[5] The salaries component of the annual expenditures has dominated the total expenditures. Furthermore the capital investments have almost disappeared in the expenditures of 2009, 2010, and 2011.

[4] All the directors interviewed highlighted financial challenges in managing the institutes.

[5] Until 2013, the three components were known as personnel emolument (now compensation), recurrent expenditures, and assets (development).

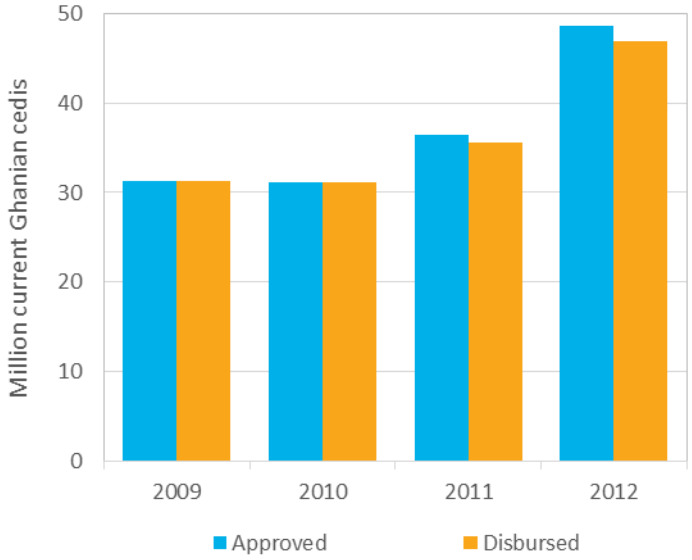
Figure 7. CSIR's expenditures by cost categories, 2000–2011



Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

The process of funding actually begins with the public institutions presenting and defending their budgets to the government through the Ministry of Finance. Usually, the approved budget after the defense is much less than the requested funding. For example, in 2010, only 41 percent of the total budget CSIR presented was approved. But even when approved, there is no guarantee that all the approved funds will be released or disbursed. During the year, difficulties in government economic and financial management may demand cuts in approved levels to various institutions. The CSIR is often affected. However, discrepancies between the approved and the actual disbursement of the funds from government are small because salaries dominate (Figure 8).

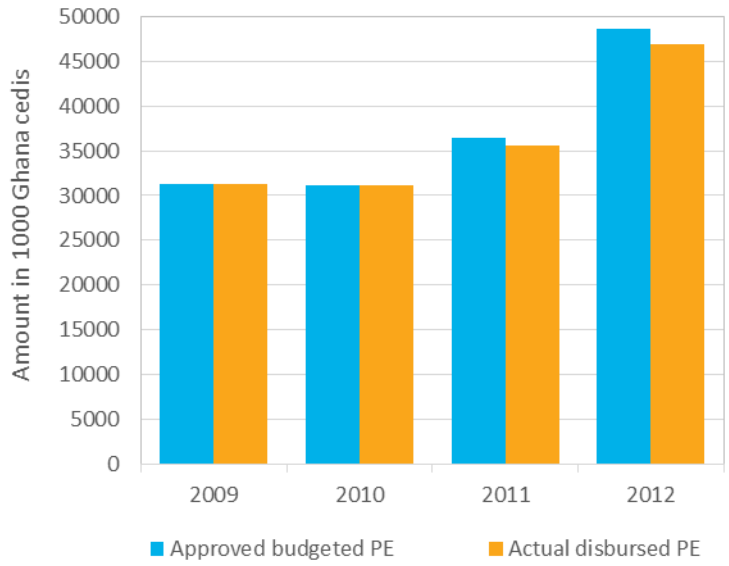
Figure 8. Approved versus actually disbursed budget (in million Ghana cedis), 2009–2012



Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

Usually when there are cuts, the government makes an effort to pay salaries and wages. As a result approved funding for personnel compensation is close to the actual disbursement (Figure 9). CSIR staff members, as do workers in other public establishments, regularly receive their salaries.

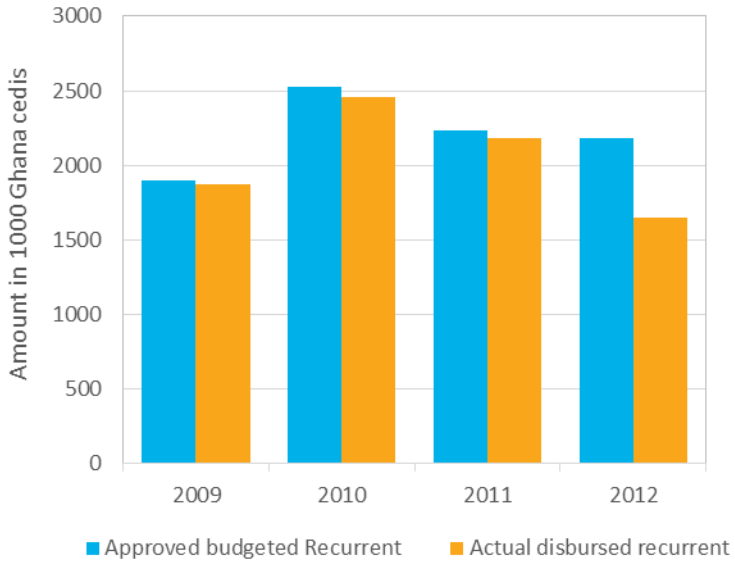
Figure 9. Government funding allocated to personnel compensation



Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

For the goods and services component, which is a recurrent expenditure, there is a pronounced difference between the approved and the actual disbursement in 2012 (Figure 10).

Figure 10 Government funding allocated to recurrent expenditures

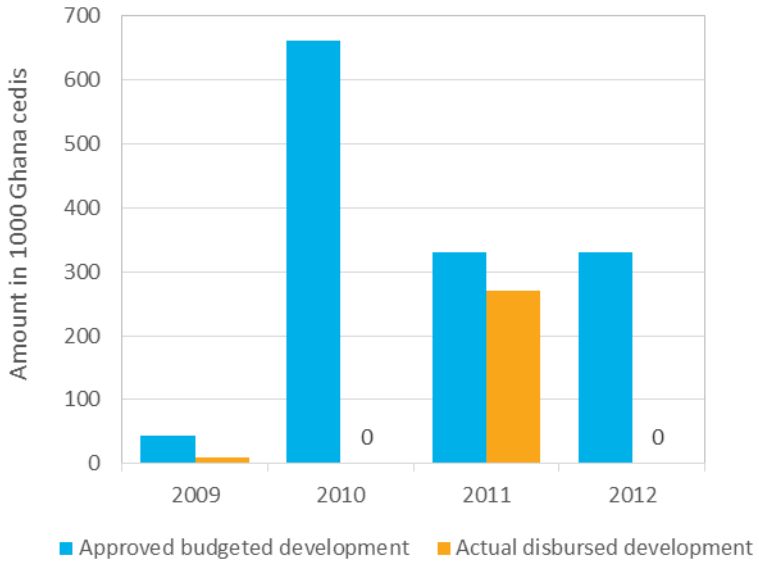


Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

The recurrent component is where the operational budget for the institutes lies, any shortfall definitely affects R&D activities. However, the government is aware that various donor agencies and funding sources fill the gaps in funding resources for CSIR. Currently the actual disbursement of the recurrent component of government subvention is less than the approved.

The difference between the approved and the actual disbursed budget for development is even larger than the other two components of government funding (Figure 11).

Figure 11. Government funding allocated to development



Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

From 2009 to 2012, actual disbursement of the approved budget was only about 15 percent. This share would have been lower if 2011 were excluded. In all, apart from the salaries component of the budget, which does not show too much variation between the proposed, approved, and disbursed funding, CSIR has received only about 20 percent of the approved budget.

The key policy issue with respect to the science, technology, and innovation sector—not just with CSIR—is the government's intention to "wean" scientific research institutions off government funding. Above anything else, the government has emphasized commercialization for these institutions and CSIR as a whole. As a result, CSIR's R&D resources are dwindling. The government wants to see a CSIR that not only can generate its own resources to finance its operations but can also undertake infrastructural development and pay its staff. While this goal is laudable, the expectation of the government to achieve this goal within two years is unrealistic, given the level of the funding required and CSIR's present capacity for internal generation of funds. In general, less than 4 percent of CSIR's total budgetary requirement is generated internally. Increasing this level to even 10 percent in the next two years calls for some drastic measures. Therefore, the government needs to set more realistic goals for internal generation of funds.

Nongovernment sources of funding are becoming increasingly significant in CSIR's operations. Given the continuing decrease in the recurrent component of the budget and the government's eagerness to wean scientific institutions off government funding, donors are expected to play even larger roles in meeting Ghana's R&D needs. However, if donors have to fully fund R&D in Ghana, their priorities may override national R&D priorities. Another crucial issue is also whether donors will be willing to pay the full costs. Donor funding does not generally extend to all costs, such as salaries and the

cost of utilities. In some cases, donors may fund some of these costs, but expecting donors to fund the full cost of R&D is not feasible.

During 2008–2012, funding for actual research activities is currently derived from international agencies (29 percent), regional organizations (28 percent, and bilateral donors (24 percent). The European Union and the CGIAR centers are the main donors among these. World Bank funding, mostly through WAAPP accounted for 9 percent during this period. Domestic sources of funding accounted for only 5 percent of total project funding received during 2008–2012. The much lower level of national funding shows the priority the government gives to operational budgets for conducting research. While the government pays researchers' salaries and costs of daily operations, it does not invest substantially in R&D activities. Paying salaries without the necessary commensurate operational budget is very much like asking researchers to accept payment for doing no work. Fortunately, for most of the institutes, there are enough projects to keep some of the researchers busy. Institutes, such as CRI, SARI, and FORIG, receive significant amounts of donors funding for their research operations.

WAAPP is also an important donor to CSIR. During WAAPP's implementation phase, competitive grants—through the Competitive Agricultural Research Grant Scheme (CARGS)—are given to researchers to promote research that would provide substantial benefits to farmers and other end users (CSIR and MOFA 2013b). CARGS is managed by a board chaired by CSIR's Deputy Director-General. Board membership includes representatives of agriculture-based nongovernmental organizations (NGOs), farmers, and special projects under MOFA. Most of CSIR's agricultural research institutes have benefited from the WAAPP competitive grant scheme, including CRI, SARI, and SRI.

Table 5. Breakdown of funding sources for research programs (in 1,000 Ghana cedis), 2008–2012

Donor	2008	2009	2010	2011	2012	Total	Shares
National							
Government (non-budgetary)	190.4	326.1	406.1	233.1	235.9	1,391.6	4.4
Domestic business	5.4	14.9	36.1	20.1	50.7	127.2	0.4
Subtotal	**195.8**	**341.0**	**442.2**	**253.2**	**286.6**	**1,518.8**	4.8
Regional							
Alliance for a Green Revolution in Africa (AGRA)	293.6	816.5	640.0	20.0	20.0	1,790.1	5.7
West and Central African Council for Agricultural Research and Development (CORAF/WECARD)	0.0	82.8	237.1	483.4	447.4	1,250.7	4.0
African Agricultural Technology Foundation (AATF)	15.7	28.7	149.9	27.3	181.9	403.6	1.3
Other	475.4	265.0	1,105.7	2,138.1	1,659.0	5,643.2	17.8
Subtotal	**784.7**	**1,193.0**	**2,132.7**	**2,668.8**	**2,308.4**	**9,087.7**	28.7
Bilateral							
Canada	23.0	74.0	180.0	555.8	102.9	935.7	3.0
Denmark	102.6	50.6	93.0	72.8	112.6	431.5	1.4
European Union	211.6	50.4	91.0	104.2	2,913.8	3,371.1	10.7
France	10.0	15.2	29.0	262.6	110.1	426.9	1.3
Japan	6.8	74.8	176.4	29.2	58.7	345.9	1.1
United Kingdom	19.4	10.4	7.1	62.5	1,102.2	1,201.5	3.8
Other	72.0	58.9	54.1	331.7	217.4	734.2	2.3
Subtotal	**445.5**	**334.2**	**630.6**	**1,418.8**	**4,617.7**	**7,446.8**	23.5

Donor	2008	2009	2010	2011	2012	Total	Shares
Development banks							
African Development Bank (AfDB)	138.2	0.0	120.0	0.0	0.0	258.2	0.8
World Bank	647.4	220.0	367.5	732.0	867.2	2,834.0	9.0
Subtotal	**785.6**	**220.0**	**487.5**	**732.0**	**867.2**	**3,092.2**	9.8
International							
Africa Rice	86.8	70.4	0.0	62.7	0.0	220.0	0.7
International Institute of Tropical Agriculture (IITA)	123.0	97.5	48.5	163.7	373.5	806.1	2.5
International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT)	44.0	29.6	0.0	368.4	32.7	474.7	1.5
International Center for Tropical Agriculture (CIAT)	35.2	94.0	111.4	350.2	216.5	807.3	2.6
Other CGIAR	87.4	141.4	161.2	227.8	305.8	923.6	2.9
International Fund for Agricultural Development (IFAD)	50.4	62.7	74.5	84.8	72.0	344.4	1.1
International Fertilizer Development Center (IFDC)	47.5	318.5	12.0	545.2	24.3	947.5	3.0
International Tropical Organization (ITTO)	320.1	286.6	223.9	166.0	95.0	1,091.6	3.4
Other	840.6	123.0	972.8	774.7	684.9	3,395.9	10.7
Subtotal	**1,635.1**	**1,223.6**	**1,604.3**	**2,743.5**	**1,804.6**	**9,011.1**	28.5
Other foreign							
Foreign universities	93.9	84.3	90.2	214.1	110.1	592.6	1.9
Foreign business	0.0	0.0	44.7	122.5	181.5	348.7	1.1
Other	2.5	97.9	46.0	276.0	128.3	550.7	1.7
Subtotal	**96.4**	**182.2**	**181.0**	**612.6**	**420.0**	**1,492.1**	4.7
Total	**3,943.1**	**3,494.0**	**5,478.2**	**8,428.8**	**10,304.5**	**31,648.7**	100.0

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

RESEARCH INFRASTRUCTURE AND RESOURCES

The study extended also to the infrastructure for scientific research and the overall institutional environment in which researchers need to work. The elements include the laboratories, equipment, and incentive systems for the researchers.

Regarding scientific infrastructure, the study shows that while the appropriate laboratories have been provided for researchers to work in most of the research institutes, there are issues relating to their maintenance, rehabilitation, and operation. A survey conducted in CSIR in 2009 highlighted the need for upgrading laboratories and equipment (CSIR, 2009). A recent study of Ghana's science equipment policy underscored the deficiencies in Ghana's scientific laboratory infrastructure, including in CSIR (STEPRI 2014).[6]

For example, while WRI listed available scientific equipment, such as atomic absorption spectrophotometer, gas chromatograph-mass spectrometer, ultraviolet spectrophotometer, and ion chromatograph, it also listed urgently needed equipment that was not available, including inductively coupled plasma–mass spectrometry and high-performance liquid chromatography. In the study, OPRI

[6] This study is ongoing, and the report is not yet completed.

also provided a detailed listing of some scientific equipment needed for its coconut research program. Thus, the study highlighted that Ghana's scientific institutions are grappling with challenges related to the scientific infrastructure for research, including:

- inadequate funds to budget for scientific equipment;
- no exemption of duty on research equipment, which could help simplify clearance;
- inadequate logistics;
- obsolete scientific equipment that does not provide reliable results;
- inadequate training of scientific staff on the use of scientific equipment; and
- almost no local content—very few or no local manufacturers of scientific equipment (STEPRI 2014).

As the funding sections of the report have shown, the government has not given priority to investment in infrastructure. This must change to ensure that Ghana's laboratories and scientific equipment are capable of supporting meaningful research.

PERFORMANCE EVALUATION

The performance of the researchers can be assessed by using various indicators. Some of the key indicators this study focused on are agriculture-related publications and technologies or innovations produced. The study also assessed extension and technology transfer activities.

Publications by CSIR Researchers

The year 2009 was the lowest point of performance for CSIR researchers in publications, with the highest point being 2010 (Table 6). Generally, peer-reviewed journal articles are at the top of the ranking for any list of publications in a scientific institution. Throughout the five-year period, journal articles ranked highest on the whole in terms of the ratio. However, what is of concern is that books—the embodiment of the knowledge accumulated over time—ranked lowest. Books usually take much longer to prepare, and given the relatively narrow confines of researchers' disciplines, they may attract smaller audiences. Institutional strategies should be developed to address the need for dissemination of knowledge accumulating in the CSIR. For example, writing workshops and clinics can assist researchers with producing journal articles. There are already incentives for publications in CSIR's criteria for promotion. However, other incentives can be instituted, such as annual prizes for best journal papers (in terms of numbers and quality or where published) and grants for book publications.

Table 6. Number of publications by CSIR, 2008–2012

Types of publication	2008	2009	2010	2011	2012
Journal articles	118	89	115	123	103
Books	3	1	23	9	2
Chapters in books	13	4	18	4	7
Scientific articles/publications	112	32	49	43	38
Papers and posters presented at conferences	39	48	42	47	11
Nonscientific publications (e.g., newspaper, magazine articles)	24	10	20	22	35
Total	**309**	**184**	**267**	**248**	**196**
Total number of publications per researcher	**0.93**	**0.55**	**0.78**	**0.65**	**0.52**

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

Plant Varieties Developed and Released by CSIR Researchers

The research institutes' production of technologies or innovations reflects the extent to which they address their mandates and connect with the contextual needs of the end users—e.g. farmers and micro or small-scale processors. The number of technologies coming from these institutes is only indicative of the culmination of their R&D efforts. The yearly totals may be useful only in terms of the how these technologies were made ready for the end users in the respective years. However, often the R&D efforts span more than one year; therefore, one year should not be "given all the credit."

Table 7 illustrates the diversity of genetic resource innovations coming from the CSIR institutes where plants are actively bred—CRI, SARI, and OPRI. These food crops have high value for food security. Maize, in particular, is an important staple. The issue is that no technologies produced are worthy of patenting. Even the crops were not registered, as Ghana has yet to pass regulations governing plant breeders' rights. The non-acquisition of intellectual property, as patents or anything else, denies the CSIR the opportunity to reap the returns on its R&D from royalties.

Table 7. List of new plant varieties released, 2008–2012

Institute	Crop	Variety	Release year	Remarks	Patented
CRI	Lowland rice	Wakatsuki	2009	Resistance to leaf blast and lodging	No
	Lowland rice	Amankwatia	2009	Resistance to lodging	No
	Lowland rice	Bodia	2009	Resistance to leaf blast and lodging	No
	Lowland rice	Sakai	2009	Resistance to leaf blast and lodging	No
	Upland rice	Otoo emo	2009	Resistance to Cassava mosaic virus	No
	Upland rice	Emo tea	2009	Resistance to Cassava mosaic virus	No
	Cassava	CSIR-Ampong	2009	Resistance to Cassava mosaic virus	No
	Cassava	CSIR-Buroni bankye	2009	Resistance to Cassava mosaic virus	No
	Cassava	CSIR-Sika bankye	2009	Resistance to Cassava mosaic virus	No
	Cassava	CSIR-Otuhia	2009	Resistance to Cassava mosaic virus	No
	Cocoyam	Gye me di	2012	Moderately tolerant to drought	No
	Cocoyam	Akyede	2012	Moderately tolerant to drought	No
	Cocoyam	M'ayeyie	2012	Moderately tolerant to drought	No
	Groundnut	Obolo	2012	Moderately tolerant to drought	No
	Groundnut	Yenyawoso	2012	Moderately tolerant to drought	No
	Groundnut	Otuhia	2012	Moderately tolerant to drought	No
	Groundnut	Oboshie	2012	Moderately tolerant to drought	No
	Cowpea	Hewalɛ	2012	Moderately tolerant to drought	No
	Cowpea	Videza	2012	Moderately tolerant to drought	No
	Cowpea	Asomdwee	2012	Moderately tolerant to drought	No

Institute	Crop	Variety	Release year	Remarks	Patented
	Sweet potato	CRI – Danayuie	2012	Moderately tolerant to drought, yield 18 t/ha	No
	Sweet potato	CSIR-Ligri	2012	Moderately tolerant to drought	No
	Sweet potato	CRI – Patron	2012	Moderately tolerant to drought	No
	Sweet potato	CRI-Bohye	2012	Moderately tolerant to drought	No
	Maize	Aseda	2012	Moderately tolerant to drought	No
	Maize	Opeaburoo	2012	Moderately tolerant to drought	No
	Maize	Tintim	2012	Moderately tolerant to drought	No
	Maize	Ɔwanwa	2012	Moderately tolerant to drought	No
	Maize	Ɔdomfo	2012	Rich in pro vitamin A	No
	Maize	Homanpa		Rich in pro vitamin A	No
SARI	Maize	CSIR-Sanzal-sima	2012	Striga resistant	No
	Maize	CSIR-Ewul-boyo	2012	Drought resistant	No
	Maize	CSIR-Tigli	2012	High yielding	No
	Maize	CSIR-Wang Dataa	2012	Drought and striga resistant	No
	Maize	CSIR-Bihilifa	2012	Drought and striga resistant	No
	Maize	CSIR-Zonfa-bihi	2012	Drought and Striga resistant	No
	Soyabean	Afayak	2012	Shattering resistant	No
	Soyabean	Songda	2012	Shattering resistant	No
	Soyabean	Suong-Pungun	2012	Shattering resistant	No
	Rice	Gbewaa	2010	Aromatic, high yielding	No
	Rice	Nabogu	2010	High yielding	No
	Rice	Katanga	2010	High yielding	No
	Rice	NERICA 1	2010	Aromatic	No
	Rice	NERICA 2	2010	High yielding	No
	Cowpea	PadiTuya	2008	High yielding	No
	Cowpea	Songotra	2008	Striga resistant	No
	Cowpea	Bawutawuta	2008	Striga resistant	No
	Cowpea	Zaayura	2008	High yielding	No
CSIR-OPRI	Oil Palm	DXP cross 61	2012		No
	Oil Palm	DXP cross 133			No
	Oil Palm	DXP cross 134			No
	Oil Palm	DXP cross 135	2012		No

Source: Compiled by authors from ASTI/IFPRI–CORAF/WECARD–STEPRI survey data.

Transfer of CSIR-Developed Technologies

The issue of technology transfer has become crucial, given the questions being raised on the relevance of R&D in government circles and the current policy drive toward greater commercialization. To provide a platform for enhancing commercialization, the government needs to promote the use of the developed technologies and to make the users of the technology aware of their availability.

In the case of farmers, the usual bridge between the research system and farmers is the extension system instituted under the auspices of MOFA. The national extension system has been devolved to and connects with the districts, where trained extension officers are in each of the 124 District Assemblies and 10 Municipal Assemblies in Ghana (see Ghana Districts website). The RELCs, which MOFA and the CSIR are operating, are meant to provide demand-driven services to farmers. At the national level is a National Coordinating Committee, comprising the Chief Director and five directors of MOFA, the Deputy Director-General of the CSIR, three farmers' representatives, and two representatives of agricultural NGOs, among others. There is also a National RELC Secretariat at the national level. At the regional level, the RELCs are operating in Ghana's ten administrative regions. The significance of the RELCs at the regional level is the fact that ARI, OPRI, CRI, and SARI serve as the coordinating research institutions. In the RELCs, the roles of the researchers are to:

- develop technology in response to farmers' needs;
- participate in regional and district planning sessions and RELC meetings;
- develop technical bulletins and other relevant extension materials;
- participate in and provide technical backstopping for technical review meetings;
- monitor and evaluate research activities; and
- harness human, financial, and material resources for research (CSIR and MOFA 2013a).
- The farmers' roles in the RELCs are to
- participate in planning sessions;
- adopt improved and appropriate technologies;
- harness resources to support linkage activities;
- provide feedback on technologies disseminated and adopted;
- provide information on agricultural constraints;
- generate indigenous technology; and
- lobby to influence policy (CSIR and MOFA 2013a).

In the operations of the RELCs, the direct interaction between researchers and farmers are useful for technology transfer. Other direct mechanisms, such as the farmers' field schools and demonstration farms, also use research to transfer knowledge to farmers. However, the conventional agricultural extension system, which uses trained extension officers to reach out to farmers, is important. Agricultural extension officers are the conduits for reaching farmers with knowledge, information, and innovations. CSIR needs to devise better strategies for linking with the agricultural extension system through the extension officers, especially as the MOFA extension system has been decentralized to the districts and municipalities to enhance the impact of research at these levels.

Assessment of researchers' performance must be better structured and operationalized. Although there are requirements for management to follow up on researchers through annual appraisals, these appraisals are not seriously conducted. And while some institutes, such as FORIG and ARI, have review workshops where researchers make presentations on what they have done or are doing and are open to peer review, other institutes do not offer this opportunity for transparent review. A more effective monitoring and evaluation system will go a long way to enhance performance, by

prompting the individual researchers and the institutes on how and where to improve their performance for effectiveness.

CONCLUSION AND POLICY OPTIONS

The establishment of CSIR is premised on the need to use R&D to address contextual socioeconomic challenges, especially in the agriculture sector. Over the years, the CSIR's operations have been a subject of discussion among key stakeholders, such as policymakers and donors, with the view of how to enhance operations for greater socioeconomic impact. Key policy directions for consideration with regard to institutional framework, human resource development, and strategies for enhancing motivation and performance need to focused on the following:

- developing training and succession plans (including a skill gap analysis);
- providing mentorship with the involvement of present and past tenured researchers;
- improving incentive systems to create a more conducive work environment;
- ensuring the government's constructive engagement to enhance public funding, while making greater efforts to increase internally generated funds;
- improving R&D outputs and dissemination through better coordination and collaboration across research agencies and with the relevant sectors, such as the extension system and the private sector; and
- ensuring effective systems for monitoring and evaluation and performance assessment, to enhance delivery on mandates.

With the growth of scientific knowledge and the increasing depth of specialization, scientific human resources anywhere in the world need consistent improvement. This report highlights some gaps in the scientific human resources of some of the institutes. CSIR's efforts in addressing these gaps are reflected in staff training programs approved or sponsored institutionally, institutional policies for staff promotion, and recruitment efforts to address staff departures. There is due emphasis on training to the highest level (PhD), and recruitment has focused on bringing younger scientists into the CSIR institutes. Given that much of the training has been made possible through scholarships and donor support, it is necessary to strategize to ensure the continued development of CSIR's human resource base. The disciplinary gaps in some of the institutes can be filled by customized training for some of the researchers, to equip them for the specific research tasks. However, the overall strategy for human resource development must be based on a skill gap analysis to ensure its effectiveness.

The strategy for human resource development also needs to take advantage of internal opportunities. The survey highlights opportunities for mentorship through nurturing professional relationships between young researchers and their senior peers. The present and past principal and chief research scientists can be engaged in mentorship programs.

CSIR's incentive system should be enhanced. Researchers have emphasized the need for opportunities for scientific achievement and career advancement, which can be realized by making available resources for research and providing the necessary scientific laboratories and equipment. Meeting these needs requires a strategic approach created and directed at the level of management of the separate institutes and CSIR as a whole.

Where the government appears to be eager to relinquish its responsibility for funding R&D, CSIR needs to devise deliberate strategies for improving and sustaining government support. Currently donor funding is driving R&D in Ghana. However, donor funding cannot replace public funding if national priorities must still underline the researchers' work.

Showing evidence of good work and positive socioeconomic impacts is important for encouraging all stakeholders to continue to support and contribute to the work of CSIR. This can only be done when R&D outputs are finely tuned and applied to socioeconomic uses. In this regard, the linkages with the extension system are vital. While researchers must engage with farmers through the training they organize for them, it is important for them to link effectively with extension officers, to reach wider networks of farmers.

Finally, the institutional framework for monitoring and evaluation and performance appraisal should be strengthened. The relevance of CSIR lies mainly in its capacity to address contextual challenges, especially in the agricultural sector where most of its institutes operate. Therefore, management needs to improve the system of assessing how researchers perform, not necessarily in the punitive sense, but with the rationale to strengthen their motivation for good performance.

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ABOUT THIS REPORT

This report is part of an in-depth assessment of the critical issues surrounding the human, financial, and institutional capacities in West African agricultural research that was undertaken during 2013–2014. Such an assessment is key to the development of national and regional policy recommendations that will ultimately feed into a regional agricultural research strategy for West Africa. The assessment was collaboratively conducted by the Agricultural Science and Technology Indicators (ASTI) program of the International Food Policy Research Institute (IFPRI), the West and Central African Council for Agricultural Research and Development (CORAF/WECARD), and the national agricultural research institutes of six West African countries. Other countries included in the assessment were Benin, Burkina Faso, Ghana, Senegal, and Sierra Leone.

Gert-Jan Stads and Nienke Beintema from ASTI/IFPRI and Mbène Dièye Faye from CORAF/WECARD co-managed the assessment, the outputs of which have not been peer reviewed. Any opinions are those of the author(s) and do not necessarily reflect the policies or opinions of IFPRI, CORAF/WECARD, or CSIR.

ABOUT ASTI, IFPRI, AND CORAF/WECARD

Working through collaborative alliances with numerous national and regional R&D agencies and international institutions, ASTI is a comprehensive and trusted source of information on agricultural R&D systems across the developing world. ASTI is led by IFPRI, which—as a CGIAR member—provides evidence-based policy solutions to sustainably end hunger and malnutrition and reduce poverty. CORAF/WECARD is a nonpolitical organization of the national agricultural research systems of 23 countries in West and Central Africa. It aims to increase the efficiency of agricultural research in the region in order to facilitate economic growth, food security, and export competitiveness through productive and sustainable agriculture.