Chapter 15

THE ROLE OF CGIAR IN AGRICULTURAL RESEARCH FOR DEVELOPMENT IN AFRICA SOUTH OF THE SAHARA

Harold Roy-Macauley, Anne-Marie Izac, and Frank Rijsberman

Despite the impressive growth of African agriculture in the past two decades, the pressing need to accelerate agricultural productivity growth is widely recognized. Much of the solution to achieving sustainable food security and nutrition depends on improving production in Africa, without increasing the environmental footprint of agriculture (Chapter 1, this volume). The food gap in Africa south of the Sahara (SSA), currently met through imports, provides a significant potential market for mostly poor and hungry smallholder farmers to expand their output and improve their livelihoods. For this potential to materialize in a situation of increasingly interconnected international markets and in the presence of subsidies in various Organisation for Economic Co-operation and Development countries, farming in the region must become more market oriented and competitive. Improvements in agricultural productivity must come from a farm sector that is rapidly expanding onto more marginal land, with a natural resource base that is often degrading or facing competition from other sectors, and within the context of the adverse impacts of climate change. Moreover, this improved productivity must be achieved, in large part, by farm families operating on less than two hectares of land and with extremely modest physical and human capital.

Turning this situation around constitutes an agenda of transformation that depends on improvements in many dimensions of the agricultural and rural sectors, as has been discussed throughout this volume. A large range of actors are involved in efforts to take advantage of opportunities, achieve major agricultural changes, and create new system-level conditions beyond those of the field or farm. CGIAR has also been evolving over time. Its scientists, for example, used to be held primarily accountable for producing global public goods as measured by publications in high-impact, peer-reviewed journals. Today—although publications continue to be an important indicator of quality—CGIAR scientists are also required to demonstrate how their results

trigger development outcomes (ex ante), and to assess the impacts of these outcomes (ex post) (Chapter 12, this volume).

This chapter reviews CGIAR's involvement in agricultural research for development (AR4D) in Africa throughout the four decades of its existence, analyzing its capacity to respond to the region's development challenges. The discussion covers recent CGIAR reform, including potential processes for aligning with African research and development (R&D) to ensure that international public goods make a positive contribution to national development challenges. The chapter further discusses opportunities for CGIAR to strengthen learning mechanisms and develop evolutionary approaches by creating partnerships between CGIAR Research Programs (CRPs) and institutional structures involved in the implementation of national and regional agricultural investment programs. The role and importance of subregional organizations (SROs) in Africa, mandated by regional economic policy institutions, in facilitating this process is also discussed.

CGIAR's Evolving Involvement in Africa

The CGIAR Consortium is a strategic global partnership of organizations and donors involved in agricultural research that was founded in 1971 to provide science-based solutions to low crop productivity, starting with wheat, maize, and rice. Currently, CGIAR is a network of 15 international agricultural research centers employing more than 8,000 scientists and staff operating in more than 100 countries worldwide. The consortium's research in SSA has evolved considerably over time, as have the objectives pursued, the research methods used, and the associated partnerships forged in both the research and the development sectors. Initial attempts to replicate approaches that led to the Green Revolution in Asia did not work, and CGIAR drew lessons from this failure. A short synopsis of the main approaches to research and partnerships implemented during 1971–2009 and since 2010, elucidates lessons and characteristics of the roles CGIAR has played in the region, as well as its comparative advantages in international agricultural research.

CGIAR's Evolving Research Agenda in Africa South of the Sahara

CGIAR was created in response to widespread concerns in the mid-20th century that rapid increases in human populations would continue to lead to widespread famine, which parts of Asia were already experiencing. CGIAR's main goal was focused on reducing hunger by increasing the productivity of staples in small farms; breeding improved cereal varieties was its

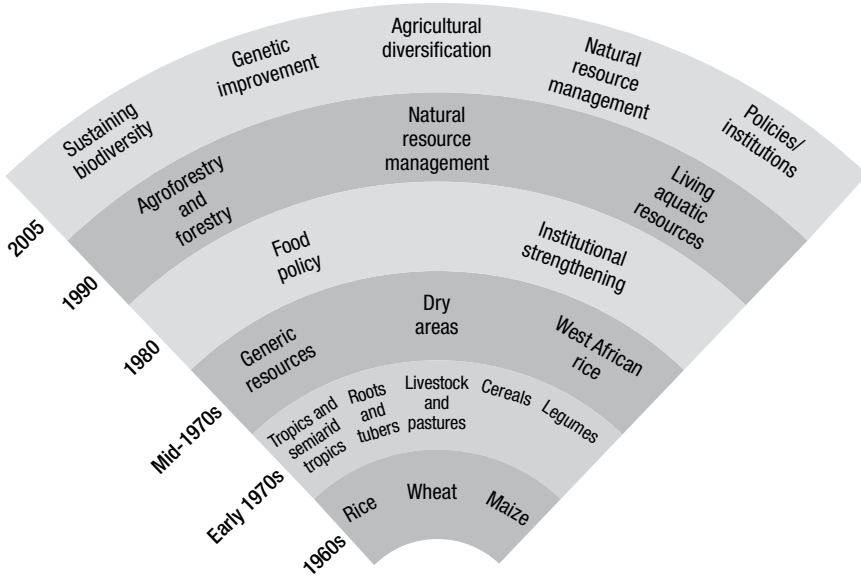
main priority (Alston, Dehmer, and Pardey 2006). With support from the Rockefeller and Ford foundations, high-yielding, disease-resistant varieties, were developed at the International Rice Research Institute (IRRI) and International Maize and Wheat Improvement Center, which were established in 1960 in the Philippines and in 1963 in Mexico, respectively. These varieties dramatically increased production of staple cereals and sowed the seeds for the Green Revolution in Asia.

India, for example, was turned from a country regularly facing starvation in the 1960s to a net exporter of cereals by the late 1970s. This success was achieved with CGIAR acting as the central node of international breeding networks, including national agricultural research institutes (NARIs), which were selecting locally adapted varieties and facilitating germplasm exchange, through the collective effort of many researchers working on the narrowly focused problem of breeding. Furthermore, the Government of India provided all the institutional and policy support needed for these high-yielding varieties to be adopted and rapidly scaled out.

CGIAR's dominant research approach during the 1970s and most of the 1980s thus focused on the problems of breeding more productive crops, often in the context of irrigated agriculture, and for farmers who had reasonably good access to fertilizer and pest control techniques, inputs, and markets. However, this approach, which was very much inspired by the Green Revolution, was not as successful as hoped in the socioeconomic and biophysical contexts of SSA, where traditional food staples were grown under extremely varying rainfed conditions and with little institutional and policy support. It was not compatible with the large diversity of African agroecological situations and farming systems, often characterized by high and difficult-to-predict production risks.

In addition, the limited success of the Green Revolution model in Africa stemmed from a variety of institutional constraints prevalent among African countries during most of the first three decades of CGIAR's existence. These included inadequate support to research and extension from the state and, consequently, relatively weaker breeding networks in SSA compared with Asia; weaker extension services; and essentially no economic incentives to induce adoption (CGIAR Independent Review Panel 2008). These challenges were further compounded by pronounced market imperfections associated with unfavorable price incentives, ineffective subsidies, and limited credit access—and, consequently, low profitability of input packages and delayed adoption of improved varieties and technologies. Also playing a significant role were weak governance and, thus, political and social instability among the

FIGURE 15.1 CGIAR's evolving scope and mandate



Source: CGIAR Science Council (2006).

newly independent countries, and lower population density with its implications for market access, infrastructure, and service provision.

In the continuing quest to improve the contribution of CGIAR research to agricultural development in Africa, and in view of the very difficult replication of Green Revolution approaches outside of Asia, CGIAR's initial focus evolved over time (Figure 15.1). The focus of research expanded to include other tropical crops and commodities, such as cassava, bananas, plantains, yams, beans, pulses, oil seeds, chickpeas, lentils, sorghum, potatoes, sweet potatoes, millet, livestock, and fish. In parallel with the addition of crops, livestock, and fish was the realization that breeding could not resolve all constraints faced by farmers; improved and more productive germplasm had to be accompanied by improved policies and practices, including natural resource management (NRM), to provide a more enabling environment for the adoption of technologies by farmers (Chapter 12, this volume).

Among the initial four crop-improvement centers, the International Institute of Tropical Agriculture, created in 1967, was headquartered in Africa. This was followed in 1971 by the West Africa Rice Development Association (WARDA), an intergovernmental center now renamed the Africa Rice Center.

Over the years, two other international centers were headquartered in Africa: (1) the International Livestock Research Institute, resulting from the merger of two previously independent centers, the International Laboratory for Research on Animal Diseases (ILRAD) and the International Livestock Center for Africa (ILCA); and (2) the International Center for Research on Agroforestry (ICRAF), since renamed the World Agroforestry Centre. Other centers were created in other continents, and most opened regional offices in various countries in SSA.

By the 1990s, CGIAR comprised 18 centers, some specializing in NRM (forests, trees, soil, and water), and others in policy and capacity building. CGIAR also focused on the research needed to support countries in designing and implementing food, agricultural, and research policies, as well as training to strengthen NARIs and build linkages among them and with other actors in the international agricultural research system (Anderson 1998).

In parallel with the broadening of the scope of CGIAR, research approaches continued to evolve. Following CGIAR's dominant approach of the 1970s of breeding to improve the productivity of key crops, more encompassing approaches to improving agricultural productivity and the welfare of resource-poor farmers were initiated. A principal new approach was that of "farming systems," recognizing that farmers manage landholdings comprising different enterprises and a diverse range of crops, trees, and sometimes animals—a situation prevalent in SSA. This new approach required social scientists and biological scientists to work together—outside of research stations in farmers' fields—to devise not only productivity-enhancing technologies and practices, but also profitable options for resource-poor farmers. An additional new requirement was to work at the level of the entire farming system in order to understand interactions among components of the farmholding and to devise more relevant and robust solutions.

These requirements amounted to a significant scientific cultural change. Using research methods in which data were collected under farmers' conditions and without full control of relevant variables was a challenge. Until then, most scientists had worked under controlled conditions, on research stations and at the plot level. Furthermore, it was not easy for scientists, trained to consider that their discipline provides "the definitive solution to farmers' problems" to accept that other disciplines, in particular the social sciences, can make essential contributions to the design of innovations. The new systems approach embedded in farming-systems research posed various methodological challenges. Achieving success, therefore, required local and national partnerships with other relevant research institutions. The change in the

dominant scientific culture that farming-systems research brought about in CGIAR is still ongoing, given that the approach continues to be used and improved by scientists (Collinson 2000).

The integrated natural resource management (INRM) approach, which began emerging in CGIAR centers in the late 1980s and early 1990s, builds on farming-systems research by integrating sustainable management of natural resources as an objective (Chapter 12, this volume), along with productivity and profitability objectives (Izac and Swift 1994; Izac and Sanchez 2001; Clark et al. 2011). This approach requires not only agronomists, breeders, soil scientists, plant pathologists, and integrated pest management experts, for example, to work with social scientists, but also that production and systems ecologists are included and new methodological challenges addressed. This, for instance, includes measuring trade-offs at the system level among (1) productivity increases, (2) sustainability and resilience of resources, and (3) human welfare. Other methodological challenges include working at multiple scales to understand interactions across levels (Izac and Swift 1994) or building interoperational databases across the different types of data collected, including short-term, time-series data from farm surveys and field measurements at landscape/watershed scale and plot level. The results for farmers are very knowledge-intensive options compared with innovations, such as an improved variety. The approaches very often also require that policymakers be involved as stakeholders, so that the policy and institutional environments in which farmers function become more facilitative and supportive of farmers' adoption. CGIAR scientists and their partners continue to address these challenges more effectively.

More recently, the use of participatory action research methods was initiated by CGIAR scientists as a means of increasing farmers' capacity to sustainably adapt their own farming system to constantly changing socioeconomic and environmental circumstances (van de Fliert and Braun 2002; Sayer and Campbell 2003). These methods involve farmers and other stakeholders, from inception in the research for development lifecycle and throughout the different iterative loops. The purpose of this more demand-led approach, based on mutual learning among scientists, farmers, and other key stakeholders, is twofold. First, it ensures that the research undertaken is indeed responding to the actual needs of farmers and key decisionmakers, which in turn results in more rapid and substantial scaling up of results. Second, it brings about more sustainable improvements in farming systems by strengthening farmers' capacity to adapt, to use knowledge-intensive options, and to continue to amend their systems over time (Sayer and Campbell 2003). This approach builds

on farming-systems research and INRM approaches. It further requires that scientists who are cognizant of social-learning processes participate, so that appropriate and effective methods of involving and building the capacity of farmers, scientists, and other key stakeholders are implemented as an ongoing part of the participatory action research being undertaken.

CGIAR's research agenda in SSA has thus constantly evolved from a relatively simple focus on achieving significant crop productivity increases, through breeding for a few selected crops in the 1970s, toward a much more encompassing agenda. Just before the beginning of the current reform, the agenda was addressing the challenges of managing complex agroecosystems under conditions of global change. In addition to the initial objective of productivity increases, it required multidisciplinary and interdisciplinary approaches and the assessment of trade-offs among multiple objectives. In parallel with this evolution, the scope of the system enlarged through the creation of new centers specializing in a large range of food crops, livestock, fish, forestry, trees, and policy research. Under such conditions, R&D partnerships had to evolve concomitantly.

CGIAR's Evolving Partnerships in Africa South of the Sahara

The evolution of CGIAR's research agenda in SSA could not have occurred without partnerships at local, national, and international levels. CGIAR's efforts still represent a small component of the overall effort deployed in agricultural research in developing countries. It has thus depended on strategic partnerships to complement its own range of expertise, which is insufficient to successfully address development challenges. While the initial attempt to replicate Asia's Green Revolution in Africa essentially entailed partnering with networks of breeders, since most research took place on CGIAR research stations, the implementation of farming-systems, INRM, and participatory-action research required the involvement of strategic arrays of partners.

Partnerships, in particular with NARIs, became essential to conducting on-farm research from a multidisciplinary perspective; this was especially so, given that the centers implement activities in different countries at the same time, as required by CGIAR's international mandate. The circle of partners grew over time to include research institutions specializing in such areas as the environment, resource conservation, water, soils, and forestry to successfully undertake INRM research. It also included partners working at farm and landscape scales across different countries. With the exception of the very early days when CGIAR partnered with networks of breeders, CGIAR centers do not employ all the needed expertise; developing partnerships

has been a successful means of increasing the scope of available expertise to resolve challenges more effectively. Participatory action research required further partnerships with civil society organizations, communities, groups engaged in collective management of resources, farmers' groups, and key decision- and policymakers and development actors, including nongovernmental organizations (NGOs) and development banks. By the time the current CGIAR reform started, the centers had forged partnerships with a range of R&D actors throughout the countries in which they worked. The last external review of the system noted that these partnerships were wide ranging and raised questions about their nature and whether they reflected a strategic approach to partnerships (CGIAR Independent Review Panel 2008).

The quality and efficiency of the partnerships are indeed not easy to circumscribe. The alignment of the partnership models used by the different CGIAR centers with the dynamics of development and African agricultural research is difficult to assess—and the fact that each center has its own approach to partnerships only renders the task more difficult. In the 1990s and 2000s, in response to the interest of policymakers to respond to developmental needs, donors asked CGIAR and research systems in SSA to show the impact of their research outputs (CGIAR Independent Review Panel 2008). In this context, in 1999 the directors general of CGIAR's centers agreed that it was both urgent and important to improve the coordination of research for development activities at all of the centers, as well as among those of their national and subregional partners in West and Central Africa and in East and Southern Africa; WARDA and ICRAF, respectively, were asked to lead these efforts in the two subregions. The overall objective was to create an inventory of CGIAR's activities with its partners and identify ways to improve the alignment of activities, avoid duplications, and fill research gaps. The assumption was that greater alignment of objectives and approaches and more effective use of funds would trigger larger-scale impacts of the work.

Between 1999 and 2002, numerous consultations were conducted involving the SROs, CGIAR scientists, key partner institutions, the NARIs, and representatives of farmers' organizations and NGOs. The main conclusion reached was that improving the quality of the existing collaboration between CGIAR centers and their partners was the best way to integrate research activities effectively across regional partners and maximize the potential for greater impact. The consultations also led to the acknowledgment by both CGIAR scientists and partners of the need for CGIAR to collaborate

differently with scientists in the NARIs and with other partners within and beyond the national agricultural research systems (NARSs). Equitable partnerships were widely recognized as more satisfactory, more effective, and more aligned with the needs of partners than the prevailing, more academic type of collaboration. The lack of transparency, particularly in allocating funds to partners, and the "top-down" dimension of partnerships were identified as bottlenecks that had to be addressed. This general recognition and the overall recommendations to the group of directors general were accompanied by concrete proposals for integrated work on joint priorities, joint action plans, and joint fundraising.

Nevertheless, it was not until the release of the final report of the two CGIAR-appointed SSA task forces that concrete action took place (CGIAR Secretariat 2005). Indeed, the Tervuren Consensus, as it was known, determined the need for a single (legal) CGIAR entity for SSA and, as a first step, advocated the development and implementation of integrated medium-term work plans for West and Central Africa and for East and Southern Africa. The Alliance of the International Agricultural Research Centers, created by the 15 CGIAR centers in 2006, thus facilitated the design of an action plan for implementing these recommendations in the two subregions. The Alliance also funded the plans' implementation for a few years, until the commencement of the current reform in 2010, at which time the integrated work plans were discontinued (see Chapter 14, this volume, for further detail).

The impetus to implement the work plans was initially strong, but grew weaker over time—no doubt because institutional obstacles slowed progress, and the political will needed to remove those obstacles was insufficient. Institutional changes in the NARSs also led to increased competition for funding between CGIAR centers and national institutions, lowering scientists' overall interest in integrated research activities. The momentum created by the integrated work plans has not been regained. An external assessment of the impacts of the multiple reforms of CGIAR's research agenda over the past 10 to 15 years would be interesting. One hypothesis is that a series of reforms is often an indication that each reform failed to fully address structural issues—that is, did not go far enough—resulting in calls for further reforms. Another hypothesis is that a minimum of institutional stability is necessary for scientists to successfully develop new sustainable partnerships and global collaborative programs.

In the early 2000s, CGIAR created a new mechanism—challenge programs—to provide even greater incentive for its centers to forge partnerships with external institutions. Five such programs were created, adding

to—rather than replacing or displacing—existing programs. Challenge programs involved one or more centers with a variety of external partners. Four programs dealt with issues cutting across continents, such as climate change, food and water management, biofortification, and advanced crop breeding for difficult environments. One was the SSA Challenge Program (SSA-CP), whose main objective was to develop new research approaches to tackle agricultural development problems in Africa. The Forum for Agricultural Research in Africa (FARA) led and managed this program, which involved many of the centers. As part of the current reform, each challenge programs was rolled into the newly created CRPs, so that lessons learned from the SSA-CP could be used by the relevant CRPs. Indeed, some of the research sites and approaches to innovation platforms developed by SSA-CP have been further developed by the Humid Tropics and Dryland Systems CRPs.

Lessons Learned

Among the many lessons that could be drawn from CGIAR's evolving agenda and partnerships, the following five are notable, as they have been used to establish guidance for the centers in the first call for CRP proposals.

THE FIRST LESSON

The generic theory of change CGIAR used in its initial decades—which is still in use in some parts of its current research agenda—is unrealistic and too simplistic. This theory of change assumes (1) that producing new technologies and improved practices will lead to large-scale farmer adoption as long as national-level extension services are in operation, and (2) that producing new scientific evidence will convince policymakers to improve the enabling policy environment for farmers. CGIAR scientists have learned that society will not readily change its behavior in response to new scientific findings and innovations. Today, they are less arrogant about the role of science because they understand that producing new science is only a first step, and that more strategic thinking, time, and effort are needed to ensure that science influences and changes behavior. The evolution of CGIAR's research agenda in SSA exemplifies the search for an effective way of increasing the influence of agricultural science through more integrated and inclusive research approaches and partnerships.

THE SECOND LESSON

Multidisciplinary and interdisciplinary research methods and their associated partnerships, both within CGIAR and with external partners (such as in the Alternatives to Slash and Burn Program), produce relevant and robust results

that no monodisciplinary or mono-institutional approach could match (Clark et al. 2011). Such approaches, however, entail high transaction costs for scientists, who need to learn to communicate across different disciplines and to accept the multidimensional nature of the reality—and the associated knowledge base—within which they operate. Hence, CGIAR's interdisciplinary undertakings can still be unwieldy, particularly when biophysical and social scientists need to work together.

THE THIRD LESSON

The governance and management structure of CGIAR programs needs to be aligned with the research for development agenda—not the other way round. This implies that inclusive, transparent, and accountable governance and management mechanisms need to be established to facilitate and support the collaborative research being undertaken. This lesson was further reinforced by the recent external governance and management review of the CRPs (CGIAR Independent Evaluation Arrangement 2014).

THE FOURTH LESSON

It is essential that CGIAR benchmark its work in multiple sites and locations across countries in order to understand the key biophysical and socioeconomic processes that are operating and ultimately determining the performance of innovations in different environments. Indeed, this understanding is key to scaling up options successfully in different environments. To date, most of the scaling up, whether for technological, policy, or institutional innovations, still follows a trial-and-error approach. The need to first understand processes in different environments, and to have sufficient baseline and benchmark data to facilitate this understanding, has only begun to be recognized by the newly created CRPs, principally through the establishment of results-based management.

THE FIFTH LESSON

For CGIAR research to be guided by a theory of change that becomes increasingly more realistic and relevant to the needs of farmers, policymakers, and national partners, scientists must have excellent skills in learning from past mistakes. CGIAR's evolution over time shows that being flexible and adapting to a constantly changing agricultural environment with significant intellectual and scientific humility is essential to a resilient and dynamic research system. This adaptation process takes time, of course, so realistic theories of change cannot be expected to be produced by newly created CRPs; rather, they will emerge over time from this process.

The Reformed CGIAR

To meet the challenges of increased volatility and uncertainty in agricultural markets, the increasingly tangible challenges in agriculture and forestry arising from climate change and natural resources degradation, and the multiple institutional challenges confronting the CGIAR system, CGIAR embarked on a profound reform in 2008. One of the objectives was to fundamentally change CGIAR's business model by focusing on the delivery of development outcomes. The process included improving the engagement of all stakeholders in international agricultural research for development, in order to refocus the efforts of the centers and their partners on major global development challenges. This led to a new vision to reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience, including to climate change, through high-quality international agricultural research and partnerships, and a way of doing business geared toward strengthening research impact and donor harmonization.

The reform aimed to increase the relevance, effectiveness, efficiency, and accountability of CGIAR research to achieve this new vision. The last external review showed that CGIAR research was not driven by the need to resolve development challenges, that its partnerships needed further expanding, and that it was not sufficiently accountable for producing scientific results of demonstrable relevance to development challenges (CGIAR Independent Review Panel 2008). In addition, donors pointed to redundancies across the different research agendas implemented by the centers. The design and creation of CRPs were expected to remedy this situation.

Of the criteria CRPs had to fulfill to be approved, two were of overriding importance. First, all CRPs had to address "big" development challenges related, for example, to food security, rural poverty, or climate change, and to explain what results they proposed to deliver to resolve these challenges. Second, the CRPs had to embody significant new partnerships involving scientists and stakeholders from different CGIAR centers and from a large number of non-CGIAR institutions, with some specialized in research and others in development. This was in recognition that (1) development challenges cut across traditional scientific disciplines and center mandates, requiring scientists from different institutions to collaborate to provide the range of expertise needed; and (2) research alone is insufficient in bringing about sought-after impact, and research practitioners must work alongside stakeholders and development practitioners for their results to generate significant impacts. Accountability was provided by the Consortium Board, created in January 2010 to be responsible for monitoring and facilitating the progress of

CRPs toward delivering their expected results and impacts. The Consortium Board has overall governance and oversight of collective issues regarding CRPs, for the Strategy and Results Framework that underpins their work (CGIAR 2015), and for yearly reporting to donors on the use of CGIAR and bilateral funding by CRPs.

Since 2011, CRPs have been the only mechanism for funding research for development activities from the CGIAR Fund. Hence, as far as the CGIAR Fund is concerned, CRPs have replaced the previously independently conceived research agendas of the 15 CGIAR centers. The Strategy and Results Framework was not approved by donors until the end of 2012, when most CRPs had already been approved. Creating CRPs under such conditions thus had inherent limitations. Despite these limitations, all CRPs have evolved substantially since their inception because of CGIAR's long tradition and experience of learning by doing and readjusting its agenda as the need arises (Lesson 5 from the previous section). This evolution could also be attributed to the fact that both the Consortium Board and donors—organized in a Fund Council as the system's ultimate financial decisionmaking body—provided comments and requests to CRPs to improve various dimensions of their work.

The 15 CRPs collaborate with hundreds of partner organizations, including national and regional agricultural research institutes, civil society organizations, academia, and the private sector. Three of the CRPs focus on farming systems under different agroecological conditions: aquatic agricultural systems, dryland systems, and humid tropical systems. Their objective is to facilitate the sustainable intensification of farming systems in these different zones, targeting small-scale farmers vulnerable to climate and other changes. Another three CRPs address global development challenges concerning the water, soils, land, and ecosystem services nexus; the forest, agroforestry, agriculture continuum, and the role of trees within it; and the mitigation and adaptation of agriculture to climate change for food security. These three CRPs also use a whole-systems perspective with a focus on multiple scales (farming, landscape/watershed, and regional, in addition to global) in designing options to increase systems' resilience and sustainability, and to establish sound adaptation and mitigation strategies.

Seven other CRPs aim to improve the production of various crops and commodities (including livestock and fish), most often by integrating breeding into a value-chain approach. Among them they cover the main cereals grown in developing countries, as well as roots, tubers, bananas, and a range of grain legumes. One CRP specializes in policies, institutions, and markets and on the science–policy interface, providing methodological support to the large

number of other CRPs that also engage in work on policy and value chains from the perspective of their own commodity/NRM focus. Finally, one CRP specializes in improving nutrition and health through agriculture and also provides methodological support to the CRPs undertaking nutrition work from their particular perspectives.

All CRPs focus on developing, testing, evaluating, and facilitating the scaling up of the agricultural knowledge, technologies, institutional arrangements, and policies they produce. Capacity building is accomplished through degree and nondegree training and joint research. Collaborative and joint activities provide the opportunity to share knowledge and the methods used in producing it. These activities are delivering outputs, which include (1) new knowledge on research methods for complex problems in agricultural development; (2) improved varieties and breeding lines of major food crops, livestock, fish, and indigenous fruit trees; (3) new knowledge, methods, practices, and tools for the efficient management of integrated crop, livestock, and natural resources, as well as diseases and pest management; and (4) new knowledge and implementation methods on appropriate policies and institutional arrangements to provide a more favorable environment for small-scale farmers to adopt innovations.

The portfolio of 15 CRPs, after just a few years of operation,[1] is well positioned to deliver significant results and impacts regarding food security and rural poverty reduction from the perspective of cereals, roots, tubers, bananas, native fruits, and grain legumes. This research has a long CGIAR history and is scientifically robust in terms not only of crop breeding, but also of (1) climate-change research to mitigate adverse changes and support agricultural systems and crops in adapting; (2) scaling up work, in particular through value-chain approaches; (3) policy and methods development; and (4) research on the agriculture–tree nexus. Gender research is clearly being mainstreamed and contributes to an increased focus on the circumstances of the poorest and most vulnerable farmers.

The CRPs are gathering momentum in the delivery of results to improve nutrition and health, for example, by scaling up biofortified crops, improving the nutritional status of the poorest and most vulnerable, and developing methods and policy implications and recommendations. This work is proceeding rapidly but needs further expansion, for example, concerning (1) the extremely underresearched human health dimension of food systems and CGIAR's contributions to these systems and (2) the implications of the

1 The first CRPs were created in January 2011, and the last one was created in January 2013.

development challenge of providing more balanced, diversified, and nutritious diets for the overall balance of CGIAR investment.

Regarding sustainable NRM in agriculture, the portfolio has the potential to deliver more results on decreasing the environmental footprint of agriculture. Work on these issues is relatively limited to the three CRPs specializing in specific aspects of NRM (for example, trees and forests, water and land management, and climate change). Shrinking the environmental footprint of agriculture is, however, a prerequisite for strengthening agricultural resilience and sustainability and, thus, needs to be integrated more effectively into the work undertaken by the commodity-improvement CRPs. At the portfolio level, more attention is needed on ecosystem services and their contributions to resilience, sustainability, and system productivity, and to in situ biodiversity management as a potential pathway to balancing productivity, profitability, and resilience under specific circumstances.

The CRPs have begun to strengthen their approaches to value chains, innovation platforms and networks, and gender research. They can now draw lessons from their collective experiences to progress more rapidly on these issues. Ongoing tasks include monitoring progress toward the delivery of results (which is the responsibility of the Consortium Board), and developing a much more robust culture of conducting research to evaluate impacts, in particular NRM research. Traditional monitoring and impact assessment methods are suited to assessing the relatively straightforward progress toward, and consequences of, the adoption of improved crop varieties. For instance, the more complex world of multistakeholder platforms, value-chain development, or landscape assessments of the multiple effects of climate-smart agricultural practices, or of sustainable intensification of entire agroecosystems, requires new approaches. In general, and at this juncture, the ongoing CGIAR reform is seen to facilitate the contribution of the CGIAR system to achieving the bigger picture depicted in the United Nations' post-2015 Sustainable Development Goals and, more especially for Africa, by the Comprehensive Africa Agriculture Development Programme (CAADP).

The reformed CGIAR is well positioned to bring together scientists and stakeholders from various (internal and external) disciplines, experiences, and institutions to implement this bigger-picture, transdisciplinary approach (which is discussed further in the next section in the context of opportunities for Africa). While it was considered a more effective and rapid approach to solving agriculture's complex development challenges, CGIAR did not seize the opportunity in the first call for CRP proposals. As of mid-2015, however, CGIAR was introducing additional institutional changes that should

encourage the implementation of transdisciplinarity. For the call for new CRP proposals that will be implemented in 2017, these changes include (1) integrating the CRPs as a unified portfolio, rather than just a set of individual programs; (2) introducing a preproposal phase to allow concepts to be evaluated, aligned with the existing portfolio, and refined through high-level, constructive guidance before being developed into full-blown proposals; and (3) defining a "site integration" mechanism to improve county-level coordination and collaboration at selected locations.

Whether CGIAR scientists will ultimately see the value and relevance of these processes and embrace novel transdisciplinary approaches is difficult to predict. Given that barriers to the adoption of the new approaches currently exist, formally and systematically integrating them into the call for proposals would hasten the process. Indeed, it is currently financially rewarding for CRPs to make accurate, quantifiable predictions of their results a few years ahead of time, but transdisciplinary research approaches do not lend themselves well to such predictions. For truly novel approaches to be implemented widely within CRPs, such institutional barriers will need to be removed (for example, by donors).

New Opportunities for Africa

In Africa, institutional frameworks for agricultural research have shifted significantly, and new platforms, coordinating bodies, and processes have been established to increase the relevance and impact of research on development and poverty reduction. The ongoing CAADP process and recent redesign of the CRP portfolio present important opportunities for CGIAR to collaborate closely with African R&D systems to support agricultural transformation in Africa. Components of the CAADP agenda, including regional, subregional, and national agricultural and food security investment plans, have been developed with established goals, targets, and priorities. The Framework for African Agricultural Productivity, developed by agricultural stakeholders in Africa under the leadership of FARA, has encouraged SROs and their partners to broaden their focus by looking into practical, new knowledge on innovation processes; strengthening the capacity of collaborative programs to deliver; fostering leadership for pro-poor innovations; and facilitating effective communication and knowledge sharing among stakeholders in innovation processes (Chapter 2, this volume).

The establishment of national and regional agricultural investment plans (NAIPs and RAIPs) and flagship subregional agricultural productivity

programs in East, West, and Southern Africa (EAAPP, WAAPP, and APPSA) provide the opportunity for enhanced partnerships between CRPs and SROs.[2] They are also leveraging strong partnerships with NARIs outside Africa, especially the Brazilian Agricultural Research Corporation (Embrapa), and donor support. These initiatives are currently considered by the SROs as models for sustainable investments in agricultural research to create country-level impact and are emerging, next to CGIAR, as critical providers of solutions for agricultural productivity, NRM, and development policy advice.

Linkages with CRPs will provide more opportunities for CGIAR to increase the effectiveness of its work through more equitable national-level partnerships; adapt to the dynamics of AR4D in SSA at the national level; help countries meet their needs; and facilitate country-level impact, drawing lessons from all the countries in which the CRPs work. Nevertheless, coordination among CRPs, SROs, and NARSs—while seemingly less difficult than before—still lacks mechanisms to facilitate effective and coherent interactions; hence, the looming issue is establishing the necessary institutional architecture to enable these interactions. With CAADP now into its second decade of implementation, and the RAIP and CRP processes moving into their second phases, the opportunity exists to improve the institutional alignment and linkages among NARSs, SROs, and CGIAR.

Recognition of the need to do so emerged from discussions during the Dublin process, initiated in 2011. The purpose was to identify where the greatest value addition could be generated to support the next decade of CAADP's implementation regarding science, technology, and innovation. This process provided a platform for the African Union Commission (AUC), FARA, the SROs, World Bank, United States Agency for International Development, EU, and CGIAR to engage in discussions that explored filling gaps in research investments, avoiding duplication of efforts, matching investments to priorities, and defining ways to enhance the linkages between NAIPs/RAIPs and CRPs to support CAADP's ongoing momentum. Discussions also focused on deepening the alignment of Africa's agricultural research, extension, and education programs and of collaborations with those of CGIAR and its partners to facilitate the process of African agricultural

2 The NAIPs and RAIPs are being coordinated by regional economic communities, especially in West and Central Africa through the Economic Community of West African States and Economic Community of Central African States. The agricultural productivity programs have been developed with World Bank–funded national loans and are based on the principle of regional integration and the creation of spillover effects (Chapter 14, this volume); their implementation is being coordinated by the SROs.

transformation. Various work streams were designed and executed via a partnership among AUC, NEPAD Agency (the planning and coordinating agency of the New Partnership for Africa's Development), FARA, the SROs, CGIAR, and development partners.

In January 2013 a memorandum of understanding (MOU) between AUC and CGIAR formalized the process, outlining six key activities:

1. developing an effective plan to align CRPs with the research programs of African institutions and CAADP investment plans;
2. developing a Science and Technological Agenda for African Agriculture;
3. developing a joint plan to support regional and subregional research activities to increase the efficiency of research investment Africa-wide;
4. developing joint African and CGIAR technology platforms (that is, subregionally based partnerships) to assist countries in identifying, accessing, and using the latest knowledge and technology to support the priority commodities and value chains specified in national CAADP investment plans;
5. providing demand-driven, client-oriented technical support in the design of national and regional medium- and long-term plans under CAADP; and
6. establishing a process for jointly sharing information and developing a knowledge base to underpin the dissemination of best practices in institutional development, policy development, and capacity building for agricultural research.

The Dublin process, which has gained a high profile in Africa, within CGIAR, and among development partners, is characterized by joint planning and priority setting and greater clarity about each institution's role in addressing specific agricultural issues. In addition, the process further integrates CGIAR programs with the CAADP agenda in terms of planning processes, capacity building, and implementing investment plans. The July 2015 meeting of the steering committee implementing the AUC–CGIAR agreement reviewed progress to date, recognized that numerous achievements had been made but little value had been captured, and recommended ways to improve the implementation of key activities in line with the Post-Malabo Implementation Strategy and Road Map (African Union 2015). CGIAR will

need to put in place a strong monitoring, evaluation, and learning system to effectively and efficiently capture the achievements being made through the implementation of the MOU.

CGIAR's past and current experience in implementing systemwide programs, challenge programs, and CRPs has shown that—beyond interdisciplinary research (and naturally along with reductionist, monodisciplinary research)—transdisciplinary research is needed to successfully address new and complex development challenges in agriculture. Transdisciplinarity is an approach to solving complex problems that cuts across disciplinary boundaries and integrates knowledge, tools, and ways of thinking from a large array of relevant sciences and from the perspective of key stakeholders (National Research Council 2014). This approach facilitates the design of a comprehensive framework that addresses scientific and societal challenges as they interface with multiple fields of expertise. Transdisciplinary approaches, for example, can generate a more rigorous and systematic understanding of the interconnected issues that characterize a challenge in different environments, such as the dynamics of biological, social, economic, and ecological factors in improving the productivity of a given farming system, while decreasing its environmental footprint (National Research Council 2014). Such understanding is often well developed concerning biophysical factors, but not very robust when it comes to interconnections among biophysical and socioeconomic factors. By merging scientific and other diverse expertise, including such stakeholders as farmers, transdisciplinarity stimulates innovation, but it requires an open and inclusive culture, a common set of concepts and metrics, and a shared set of institutional and research goals (National Research Council 2014). As mentioned in the previous section, additional changes being introduced within CGIAR as of mid-2015 should help CGIAR institute greater transdisciplinarity.

CGIAR will progress more rapidly toward the fulfillment of its mission in the region by working more closely with the African R&D community through the Dublin process. Indeed, these partnerships and new scientific approaches will enable existing gaps to be addressed. The innovation platforms that support transdisciplinary approaches are expected to generate an understanding of the interconnections needed for innovations to be scaled up effectively—that is, beyond current trial-and-error approaches (Chapter 13, this volume). The current paucity of information about the long-term (positive and negative) social, economic, and ecological consequences of CRP innovations can also be addressed through innovation platforms and transdisciplinary approaches. These consequences are directly related to agriculture's

long-term environmental footprint, and CGIAR must integrate this perspective throughout its future work with its African partners on improving agricultural and food systems in SSA.

The establishment of centralized programs by the SROs, strongly aligned with those of NARSs, and the creation of strong coordinating and facilitating tools have proved to be successful. More than ever, the SROs are demonstrating their effectiveness and efficiency in coordinating and facilitating agricultural research at the subregional level. They are establishing centers of excellence within NARIs to consolidate the implementation of national and subregional agricultural research based on a model that embraces the emergence of a critical mass of agricultural research stakeholders within the context of the innovation process (Chapter 2, this volume). While site integration may be new to CGIAR, the SROs developed site integration by establishing innovation platforms involving different categories of stakeholders working together on a common constraint. Most of the time, the sites targeted for the establishment of innovation platforms were already hosting government-funded projects. Under such conditions, upscaling of results is automatic. The establishment of country dialogues between NARIs and CRPs, facilitated by the SROs, will definitely render site integration a demand-driven process for CGIAR. Seen this way, site integration is something CGIAR should capitalize on to ensure alignment, linkages, upscaling, and effective fostering of transdisciplinary approaches.

Given the complexity of innovation and research processes, these centers of excellence could position themselves as catalyzing and linking agents within regional networks. They could help to identify successful experiences in multiple countries, link innovators with sources of scientific and technical information in distant locations, use action research to help adapt foreign experiences to local conditions, and promote the emergence of global research networks. Such a system would leverage stronger partnerships with advanced research institutions at the international level, including CGIAR, and promote a clear role for CGIAR within this new architecture, with NARIs acting as the central nodes of a system of decentralized experimentation with centralized learning. The performance of such arrangements should be evaluated not only via traditional research indicators, such as peer-reviewed publications, but also in terms of contributions to farmers' welfare, agricultural productivity, and the sustainable use of natural resources in agriculture at the national level. The SROs are, indeed, central coordinating mechanisms to rationalize joint planning and priority setting between CGIAR and NARSs; the CGIAR system just needs to recognize the SROs' role and empower them to do just that.

The SROs certainly do not have a funding base for this role, but the question remains as to whether the CGIAR system wants to or will give this great consideration, within its present funding windows.

* * * * *

It should be noted that, as of December 2015, the reform of the CGIAR system is still ongoing and will be until donors approve whatever the transition team proposes as the new institutional umbrella. Donors recently agreed to reducing the number of CRPs from 15 to 12, and more changes are afoot. As a result, CGIAR scientists now have to contend with constant changes, not only in the context of ongoing planning, but also in the context of short-term institutional and budget-related modifications. The transaction costs of such a constantly changing institutional environment cannot be over-emphasized and constitute a very high risk for the sustainability of the CGIAR system.

References

African Union. 2015. *Implementation Strategy and Roadmap to Achieve the 2025 Vision on CAADP: Operationalizing the 2014 Malabo Declaration on Accelerated African Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihood.* Addis Ababa, Ethiopia. Accessed August 2016. http://pages.au.int/caadp/documents/implementation-strategy-and-roadmap-achieve-2025-vision-caadp.

Alston, J., S. Dehmer, and P. Pardey. 2006. "International Initiatives in Agricultural R&D: The Changing Fortunes of the CGIAR." In *Agricultural R&D in the Developing World: Too Little, Too Late?* Edited by P. Pardey, J. Alston, and R. Piggott. Washington, DC: International Food Policy Research Institute.

Anderson, J. 1998. "Selected Policy Issues in International Agricultural Research: On Striving for International Public Goods in an Era of Donor Fatigue." *World Development* 26 (6): 1149–1162.

CGIAR. 2015. *CGIAR Strategy and Results Framework 2016–2030: Redefining How CGIAR Does Business until 2030.* Montpellier, France: CGIAR Consortium.

CGIAR Independent Evaluation Arrangement. 2014. *Review of CGIAR Research Programs Governance and Management, Final Report.* Rome.

CGIAR Independent Review Panel. 2008. *Bringing Together the Best of Science and the Best of Development*. Independent Review of the CGIAR System. Report to the Executive Council. Washington, DC.

CGIAR Science Council. 2006. *Positioning the CGIAR in the Global Research for Development Continuum.* Rome: Science Council Secretariat.

CGIAR Secretariat. 2005. *Report of the CGIAR Sub-Saharan Africa Task Forces: The Tervuren Consensus.* Accessed July 2015. www.cgiar.org/www-archive/www.cgiar.org/exco/exco8/exco8_ssa_tf_report%20.pdf.

Clark, W., T. Tomich, M. van Noordwijk, G. Guston, D. Catacutan, N. Dickson, and E. McNie. 2011. *Boundary Work for Sustainable Development: Natural Resources Management Research at the CGIAR.* Proceedings of the National Academy of Sciences of the USA. Washington, DC: National Academies Press. Accessed September 2014. www.pnas.org/content/early/2011/08/11/0900231108.short.

Collinson, M. 2000. "Introduction." In *A History of Farming Systems Research*, edited by M. Collinson. Wallingford, UK: CABI Publishing.

Izac, A., and P. Sanchez. 2001. "Towards a Natural Resources Management Paradigm for International Agriculture: The Example of Agroforestry Research. *Agricultural Systems* 69: 5–25.

Izac, A., and M. Swift. 1994. "On Agricultural Sustainability and Its Measurement in Small-Scale Farming Systems in Sub-Saharan Africa." *Ecological Economics* 11: 105–125.

National Research Council. 2014. *Convergence: Facilitating Transdisciplinary Integration of Life Sciences, Physical Sciences, Engineering and Beyond.* Washington, DC: National Academies Press.

Sayer, J., and B. Campbell. 2003. "Research to Integrate Productivity Enhancement, Environmental Protection and Human Development." In *Integrated Natural Resources Management: Linking Productivity, the Environment and Development*, edited by B. Campbell and J. Sayer. Wallingford, UK: CABI Publishing.

van de Fliert, E., and A. Braun. 2002. "Conceptualizing Integrative, Farmer Participatory Research for Sustainable Agriculture: From Opportunities to Impact." *Agriculture and Human Values* 19: 25–38.