PART 6

Synthesis
The preceding chapters of this volume have covered the spectrum of challenges facing Africa south of the Sahara (SSA) in its efforts to develop an effective and efficient agricultural research and development (R&D) system at national, subregional, and regional levels. This chapter endeavors to synthesize the key messages of the individual chapters in order to present an overview of the actions required to unlock the inherent potential of agricultural R&D in the quest for faster growth and more broadly shared development outcomes. The discussion begins with a summary of why resolving the issue of underinvestment in agricultural R&D is fundamental to advancing the region’s technical progress and, hence, raising agricultural productivity. Next, the case is made for the essential need to develop rural innovation capacity to motivate the adoption of new technologies by farmers and increase farm productivity. Finally, the chapter presents the key strategies needed to address current limitations and inefficiencies in agricultural R&D financing, human resources, organization and management, and systems-level structuring.

The Case for Increasing Investment in African Agricultural R&D

Having languished for decades, often below the rate of population growth, the rate of agricultural growth in SSA has both accelerated and spread more broadly across the region in recent years, although with significant national and subregional differences (Chapter 1, this volume). Not all countries—especially the smaller ones—partook of this acceleration, and for many it was insufficient, ruling out any hope of achieving the Millennium Development Goal target of halving the incidence of extreme poverty by 2020. Much of the agricultural growth recorded in Africa stems from expanded use of resources, some of which—like land—are finite; only a small amount of growth can be attributed to total factor productivity (TFP) growth (Chapter 3, this volume).
On the other hand, accelerated growth in agricultural gross domestic product (AgGDP) in recent years can be correlated with modest TFP growth after several decades of stagnation or decline. This is definitely good news, but the productivity of African agriculture remains very much lower than in the rest of the developing world, and the gap is increasing rather than decreasing (Chapter 3, this volume).

This low productivity undermines the competitiveness of African agriculture not only in the global market, but also in the home market. Africa is becoming increasingly food-import dependent, which most countries can ill afford (except, perhaps, for a few mineral-rich countries). Moreover, agriculture’s contribution to the overall economy in many African countries remains substantially below what could be expected for countries at the same stage of economic development elsewhere in the world (Chapter 1, this volume).

Looking to a future of rising world prices and production costs, African countries will pay a double penalty—in terms of the higher cost of imports and the lost opportunity to increase agricultural export earnings—if they fail to invest sufficiently in raising agricultural productivity. Population growth and urbanization would only exacerbate this reality, further increasing Africa’s dependence on food imports and compounding food insecurity and poverty.

The imperative of productivity growth, and the case for investment in agricultural R&D to achieve it, derives from the reality that the current trajectory of growth based on increased resource use cannot be sustained. Smallholders remain the principal farming system responsible for the greater share of overall agricultural production, and increased productivity is essential for both higher incomes and increased market participation. Higher rural incomes also reduce the incentive for rural dwellers to migrate to urban areas, a trend that exacerbates pressures on urban infrastructure and employment opportunities. In short, a productive agricultural sector is essential for balanced and equitable growth in African economies.

Technical change is a necessary contributor to productivity growth, either through spill-ins or investment in domestic research capacity (Chapter 14, this volume). In seeking spillovers of agricultural technologies, low- and middle-income countries have relatively little to gain from high-income countries, because the commodities they produce and the agroecologies within which they produce them are too different. This is unfortunate, especially compared with other types of technologies, where such gains can be massive (consider information and communications technologies, for example). More often than not, this means that Africa’s low- and middle-income countries have to rely either on their own agricultural R&D to develop and adapt the technologies
they need, or on research capacity, such as CGIAR or regional research networks. SSA’s large countries make a better return on their agricultural research investment than do the majority of small countries, which suggests that economies of scale are a key factor (Chapter 3, this volume). This has implications for how best to organize agricultural research (discussed further below).

Private investment in agricultural R&D in SSA is still very small and concentrated in a few select niches (such as hybrid seeds and export-oriented value chains) and in a few countries (most important, South Africa) that have private companies big enough to have their own research facilities and programs (Chapter 7, this volume). The most prominent private investors in agricultural R&D are multinationals, whose markets expand across national borders and, hence, whose technology platforms and staff can be shared across multiple countries. Factors that stimulate private investment in agricultural R&D include size and growth of agricultural input markets, limited government intervention in such markets, improved protection of intellectual property rights, and a stimulating R&D environment. For the medium-term future, however, most of the investment in agricultural R&D in Africa will have to rely mainly on government funding (derived from general tax revenues or through donor contributions).

As evidenced in various chapters in this book, underinvestment in agricultural R&D by governments in SSA has been widespread and persistent for decades. Only a few African countries have met the minimum investment target of 1 percent of AgGDP set by the New Partnership for Africa’s Development (NEPAD) and United Nations. In fact, the region’s average agricultural R&D intensity ratio has steadily declined in recent years (Chapter 4, this volume), which indicates that regional agricultural R&D spending has not kept pace with growth in agricultural output. Raising Africa’s investment in agricultural research to 1 percent of AgGDP implies a major expansion of Africa’s agricultural research capacity.

When AgGDP grows by 5 percent per year, agricultural research expenditures should increase by 5 percent as well, just to stay on par. Under the current scenario (whereby AgGDP continues to grow by 5 percent per year), agricultural research budgets need to grow at 10 percent per year for 15 years, in real terms, in order to double the research intensity ratio from 0.5 to 1.0 percent. This growth level may push the boundaries of what is feasible in terms of government budgets, the supply of qualified staff, management capacity, infrastructure expansion, and so on. Nevertheless, it illustrates the type of acceleration needed to realize this very crucial target, as has repeatedly been expressed in various high-level policy documents.
The Comprehensive Africa Agriculture Development Programme (CAADP) has set out to increase government support to agriculture, including agricultural R&D, to at least 10 percent of national budgets; however, only a few countries have achieved this target to date. Moreover, agricultural R&D does not score very high among reported government investment priorities. Investments in activities that generate diffuse and uncertain benefits far into the future are not very attractive to politicians who want to deliver quick and concrete results of benefit to their specific constituencies (Chapter 5, this volume). Politicians and policymakers need more education on the importance of sustained investments in agricultural R&D.

In summary, more investment in agricultural R&D is required to raise Africa’s agricultural productivity and competitiveness and, in turn, to increase rural incomes and reduce poverty, reduce food-import dependence, increase food security, and put a stop to environmental degradation. Failing to do so will jeopardize the sustainability of the current recovery process and significantly reduce the prospects for equitable and balanced growth in African economies.

**Developing Rural Innovation Capacity**

Increasing productivity requires both the new techniques and knowledge arising from agricultural R&D and improvements in rural innovation capacity (Chapter 13, this volume). Innovation capacity in this context refers to the inherent capacity of farmers to innovate, as well as the institutional environment that facilitates such innovation. Understanding how to build the capacity for farmers to innovate has become a focus of CGIAR research in development work. Leeuwis et al. (2014, 5) have identified these capabilities as the capacity to

1. continuously identify and prioritize problems and opportunities in a dynamic systems environment;
2. take risks, experiment with social and technical options, and assess the trade-offs that arise from these;
3. mobilize resources and form effective support coalitions around promising options and visions for the future;
4. link with others in order to access, share, and process relevant information and knowledge in support of the above; and
5. collaborate and coordinate with others during the above, and achieve effective concerted action.
Farmer innovation capacity, however, must be complemented by a conducive institutional environment that promotes market integration in particular. In the past, lack of access to markets and of associated support institutions has constrained the uptake of improved technologies. Nonetheless, such capacity has improved rapidly over the past decade or so following the structural adjustment and market liberalization of the mid-1990s. Input and output markets have improved significantly, although access to appropriately priced fertilizer and improved seed remains a particular constraint on productivity increases.

Several other major developments are helping raise farmer innovation capacity. For instance, rural banking is expanding, significantly aided by the capacity for cash transfers using cellular phones. The increased use of cellular phones in rural areas has also spawned improved access to information related to prices, market buyers, the quality control of inputs, and extension. Crop and livestock insurance is also being piloted based on expanded access to weather data. Access to many of these services, particularly credit and agricultural extension, are being provided through the enhanced formation of farmers’ groups, which is significantly reducing the transaction costs involved while improving social capital.

There are obvious synergies between farmers’ enhanced innovation capacity and improved access to input and output markets, credit, insurance, and information, and numerous organizational innovations are facilitating these linkages. One example is enhanced interaction between farmers and service delivery agents, which is occurring through the decentralization of public services, such as extension and veterinary services. Experimentation with innovation platforms is facilitating organizational linkages between markets, service delivery agents, and farmers, most often within the context of value chains. Such organizational innovation is key to the strategic objective of commercializing smallholder agriculture, which is often central to national CAADP investment plans. Organizational innovation—which most often builds on the formation of farmers’ groups and the encouragement of collective action—underlies efficient markets and effective service delivery by reducing the transaction costs inherent in a smallholder agrarian structure, especially where transport infrastructure in rural areas is still underdeveloped. Over the past decade and a half, rural African economies have significantly enhanced their rural innovation capacity, which in turn has been responsible for the increases in smallholder agricultural productivity and in agricultural growth rates.

Enhanced rural innovation capacity creates much stronger and more dynamic demand for new technologies and management practices. The scope
of the national research agenda to intensify African smallholder agriculture is extraordinarily wide, given highly diverse farming systems. The research system will need to respond in terms of (1) integrating higher-value crop and livestock activities into smallholder systems; (2) increasing the productivity of staple food crops; (3) integrating soil and water management techniques; and (4) enhancing crop, tree, and livestock management (including exploiting complementarities among the three). Simple reliance on improved agricultural inputs, particularly fertilizer and high-yielding varieties—while necessary—will not be sufficient to achieve sustained increases in overall farm productivity and TFP.

Given the complexity of smallholder farming systems and the spatial heterogeneity of these systems, managing the scope of the research agenda by national agricultural research institutes (NARIs) is especially complicated, particularly with limited budgets and human resource capacity. Regional approaches and links to international research networks will be essential. The organizational challenge of improving connectivity within an agricultural innovation system, while managing regional and international linkages, adds to the overall administrative and management challenges facing African national agricultural research systems (NARSs), as is discussed in the next section.

Increasing the Effectiveness and Efficiency of Agricultural R&D

Financial Resources
Organizations under financial stress often spend an extremely high share of their budgets on salaries. Not only is this inefficient, it can also seriously undermine the viability of research programs and negatively affect staff morale when research cannot be properly implemented due to lack of facilities, services, and equipment—from basic office and laboratory space, to the necessary agricultural inputs and vehicles, to computer equipment and software, and even to such fundamentals as water and electricity.

The relatively low level of investment in agricultural R&D in Africa is further constrained by the fact that it is also highly volatile, largely because of the patterns of donor funding, which often lead to “boom-and-bust” spending cycles. A certain level of volatility may be expected at the institute level, perhaps the result of large investments in training or infrastructure, but when it comes to the day-to-day operation of research programs or the maintenance
of fundamental research infrastructure, volatile spending patterns are extremely counterproductive because they interfere with the planning, conduct, and efficacy of research. It is therefore important that governments provide stable and sustainable levels of funding, not just to secure researcher salaries, but also to enable necessary operating and capital expenditures (Chapter 4, this volume).

Generating revenues internally—either through the sale of goods and services (such as improved seed, laboratory tests, contract-based research, or income from intellectual property rights) or by winning national or international competitive research grants—remains a modest source of funding for most NARIs. Governments can be overly optimistic about the share of funding that can be generated internally, and the conditions and timeframe required to make it possible; for example, research partnerships take time to develop, developing winning research proposals requires skills and experience, and the framework for securing intellectual property rights may be totally absent (Chapter 4, this volume). Hence, governments cannot rely too much on NARSs being able to internally mobilize funding sufficiently and rapidly enough to meet the financial needs of their R&D systems.

Donor funding for agriculture and agricultural research has risen in recent years, after several decades of neglect. Such funding is being derived not only from traditional donors and multilateral agencies, but also from new donors—such as Brazil, China, India, and Saudi Arabia—and new philanthropic agencies—most notably, the Bill & Melinda Gates Foundation (Chapter 6, this volume). Funding by donors always comes with strings attached, including ideas on how best to tackle Africa’s agricultural development challenges. Governments that rely too heavily on external funding for agricultural research risk having their research agenda diverted from national priorities. Such ideas are usually strongly influenced by donors’ own experiences, such as China’s achievements in rural development, India’s Green Revolution, and Brazil’s success in the Cerrado. Recipients of donor funding need to make sure that such ideas are in line with their own agricultural development strategies. Rather than relying too much on donors and development banks to fund critical research areas, governments need to more clearly identify their own long-term national priorities and design relevant, focused, and coherent agricultural R&D programs accordingly. Donor and development bank funding needs to be closely aligned with these national priorities, and consistency and complementarities among donor programs need to be ensured (Chapters 4 and 6, this volume).
CAADP’s aim of raising government spending on agriculture to at least 10 percent of the government budget can help to secure additional funding for agricultural research, but it is not a guarantee. Many African governments seem to prioritize other agricultural spending options higher than agricultural R&D. More advocacy is definitely needed within the agricultural sector itself to raise national investment in agricultural research (Chapter 1, this volume).

Human Resources

Lack of sufficient and appropriately trained and experienced human resource capacity, particularly in terms of staff with relevant MSc- and PhD-level qualifications, still places a major constraint on the quality and volume of agricultural R&D outputs in Africa. Fundamental to building strong human resource capacity in agricultural research is the development of comprehensive recruitment, training, and succession plans to fill existing and anticipated staffing gaps, and establish proper career paths for researchers. Countries and institutions with uncompetitive salary and benefits packages need to take steps to redress these barriers. The ability to build human resource capacity, however, depends on the longer-term financial and institutional capacity to do so, and on the supporting or limiting factors inherent in the policy environment. The new donor-funded regional capacity-building initiatives could play an important role in rebuilding the region’s cadre of agricultural researchers, but they will need to be upscaled to other countries and sectors (Chapter 8, this volume).

For the past few decades, student enrollment at African universities has grown rapidly, facilitated by the expansion of existing universities (including the upgrading of diploma-granting colleges to universities) and the establishment of new public and private universities. This growth took place under usually severe government budget constraints, forcing (both public and private) universities to seek part or all of their funding privately (student fees, consultancies, and so on). African universities are often overwhelmed by the number of graduate students to be trained. At the same time, many African universities are trying to move up the educational ladder and, hence, are increasingly offering specialized postgraduate programs leading to an MSc or PhD degree.

In the case of African faculties of agriculture, the number of students enrolled in most of these postgraduate programs is still quite small, which makes them relatively expensive and inefficient because they tend to lack
critical mass. Moock (Chapter 10, this volume) argues that cross-country collaboration among faculties of agriculture is needed so that the necessary level of postgraduate program specialization and quality assurance can be achieved effectively and at a viable cost. This also involves a more innovative learning approach with students attending different providers based on their desired specializations, studying outside their home country, and taking advantage of the expanding capacity in distance learning. Strategic networks of African faculties of agriculture are already emerging to bolster university-based postgraduate training and research.

In most African countries, there is a short supply of MSc- and PhD-level agricultural scientists, which is a particular challenge for agricultural research organizations and faculties of agriculture, as they are confronted by a wave of retirement of postgraduate agricultural scientists trained overseas in the 1970s and 1980s. Opportunities for overseas training in agricultural sciences fell sharply after 1990 as a result of (1) a contraction in donor funding; (2) doubts about the effectiveness of overseas training—that is, lack of relevance to African conditions and low return rate; and (3) an assumption that local faculties of agriculture would be able to supply MSc- and PhD-level agricultural specialists with relevant skills, of a decent quality, and in sufficiently large numbers. This assumption has proved incorrect; hence, developing postgraduate programs of sufficient quality that address the needs of African agriculture and ensure appropriate research skills and methods remains a central challenge (Chapter 9, this volume).

**Organization and Management**

Agricultural research entities, like all organizations, need clear strategies to translate their mission and vision statements into concrete objectives and activities. Staying focused on core objectives can be difficult in the face of—often overwhelming—day-to-day problems. A strategy needs to be followed up with a concrete plan that prioritizes activities and their implementation over time, explicitly allocating the resources required and determining the necessary trade-offs between the costs and benefits of research. A number of economic tools are available, and NARIs should increase the use of these tools during their planning phases. This in turn requires investment in better databases, data collection, and analytical capacity (Chapter 11, this volume).

Monitoring and evaluation (M&E) complements the planning process by providing feedback on the implementation of planned activities, their results
and outputs, and ultimately their outcomes and impacts. M&E tools are expected to provide accountability to government and funding agencies that money was well spent; enable implementers to learn from experience in terms of identifying problems, flexibly adjusting activities, and readjusting goals in real time; and reduce risk in decisionmaking. With some positive exceptions, such as the Kenya Agricultural Research Institute, weak M&E is widespread among agricultural research organizations in Africa; however, this mostly stems from a lack of proper planning to begin with. NARIs need to improve both their planning and their M&E efforts, which ultimately should go hand in hand. This is an obvious area where targeted training and experience are essential (Chapter 12, this volume).

While agricultural research organizations have traditionally focused on developing knowledge and technologies, they are now also being held accountable for the application of such knowledge and technologies. This accountability is forcing organizations to closely address how farmers innovate, what deters them from adopting, and what can be done to eliminate these barriers. Many factors other than just the technologies themselves will need to be put in place to ensure that innovations reach farmers and, hence, have impact. This demands a far more holistic approach to agricultural innovation and requires that researchers interact far more intensively across disciplines and among other stakeholders, including farmers. This in turn requires a massive retooling and mind shift of agricultural researchers, but also giving them the right training, incentives, support, resources, and flexibility to do so (Chapter 13, this volume).

**Systems-Level Issues**

Importanst systems-level developments need to be addressed, at both national and supranational levels, for African NARSs to be sufficiently effective and efficient. National issues include the following:

1. **Coordination among agricultural research agencies, particularly when their agendas align or overlap.** As NARSs evolve, they tend to become more complex, which calls for improved coordination mechanisms, often constrained to date by lack of resources, commitment, and goals. Nevertheless, a number of countries (Ethiopia, Kenya, and Tanzania, for example) are in the process of restructuring public agricultural research to streamline and coordinate their NARSs. Furthermore, agricultural research capacity at universities has become comparatively stronger over the years, which has added greater diversity and
complexity to African NARSs. Joint research planning and projects between faculties of agriculture and NARIs are recommended both to avoid duplication of effort and to maximize use of resources and research staff.

2. **The introduction of new funding modalities, such as competitive mechanisms and private contract-based research or public–private cofinancing of research.** This requires the necessary institutional arrangements and flexibility to mobilize multisource funding, as well as a more entrepreneurial attitude (Chapters 4 and 7, this volume). An added benefit is that such funding instruments can be used to improve coordination and alignment among agencies.

3. **Improved linkages with farmers and private and nonprofit sectors to ensure more effective agricultural R&D.** NARIs provide necessary—but insufficient—inputs into the rural innovation process. To ensure the adoption of their research outputs, NARIs must interact with an expanding private sector and an increasing array of farmers’ and civil society organizations that are important partners in identifying problems and validating technologies. These partners can also play a crucial role in lobbying government for support to agricultural R&D (Chapter 2, this volume). Through market liberalization and democratization, agricultural research has an opportunity to move from a state of near isolation to developing essential organizational linkages for rural innovation and smallholder development (Chapter 13, this volume).

4. **Improved linkages between agricultural research and extension providers.** The success of investment in agricultural research is heavily dependent not only on the quality of the research, but also on the strength of the links between research and extension providers. In addition, it is important that these two functions are structured in such a way that they do not compete with each other, especially for the same scarce resources, and that practical channels and incentives for interaction are fostered (Chapter 13, this volume).

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1 Government grants also now come with more strings attached as governments are adopting results-based funding allocation; hence, new funding methods are often also used to cement linkages among the various entities involved in conducting agricultural research (such as research institutes and higher-education or private actors).
5. The importance of convincing policymakers of the significant impact of agricultural R&D on national development goals (Chapter 11, this volume). Policymakers need information about agricultural challenges and opportunities and the alternative solutions and options that may be available. Agricultural research can play a crucial and active role in informing the policy dialogue with such information. One of CAADP’s key contributions is stimulating agricultural policy dialogue in participating countries, but this is an opportunity that agricultural research organizations have only partially seized. More can and should be done in this area.

Supranational-level systems issues have received significant attention over the past two decades, resulting in the establishment of the Forum for Agricultural Research in Africa (FARA), the subregional organizations (SROs), and more recently the subregional agricultural productivity programs funded through bilateral loans to the participating countries by the World Bank (Chapters 2 and 15, this volume). Both institutional developments aim to strengthen crossborder collaboration in agricultural research motivated by the potential efficiencies of joint resource use in the development of new technologies of mutual benefit to multiple countries.

Critical bottlenecks in addressing the supranational agricultural research agenda are the limited political and economic integration of Africa and the almost complete lack of African funds to finance joint initiatives. All supranational initiatives, particularly those implemented by FARA and the SROs, are heavily dependent on donor funding. This cannot continue indefinitely, so it is essential to start strategizing about regional funding. The “center of excellence” approach promoted by the subregional agricultural productivity programs avoids this problem by attempting to generate reciprocal spillovers of benefits among participating countries. Time will tell whether this approach will work and whether it can be sustainable in the absence of donor support.

In addition to these regional and subregional initiatives, CGIAR has continued to play a pivotal role in addressing African agricultural research issues at the supranational level. The coexistence of these various initiatives requires coordination to ensure efficient use of resources, effective coverage of topics, and alignment with CAADP priorities (Chapter 15, this volume). The Science Agenda for Agriculture in Africa, launched in 2014, is a step in this direction.
Conclusion

Agriculture in SSA is at a prospective tipping point. Agricultural growth has increased in the past decade, probably in response to the reforms of a decade before. This growth path, however, relies on the unsustainable tactic of increasing the use of finite resources. Shifting to a growth path based on increased productivity—as in the rest of the developing world—is essential if Africa is to increase rural incomes and compete in both domestic and international markets. The yield gap in African agriculture is significant; scenarios on feeding the world into the future highlight the need to increase Africa’s agricultural production. Shifting to this growth trajectory will require building on evolving improvements in market efficiency, the expanded capabilities of cellular phones to deliver a range of services, the improved responsiveness of public services to decentralization, and the expansion of farmers’ organizations—all of which, in effect, amounts to deepening rural innovation capacity. An essential component of innovation, however, is a continuous supply of improved agricultural technologies and management practices stemming from an effective and efficient agricultural research system.

The design of the agricultural R&D system in Africa must incorporate the small-country problem, the wide scope of research needs, and the heterogeneity in agroecological and socioeconomic conditions. These factors particularly affect the efficiency of agricultural research, especially in the context of limited government budgets and reliance on highly variable donor aid flows. Heterogeneity requires a significant adaptive research capacity that can most effectively be provided by NARIs. Moreover, economies of scale and scope in agricultural research point to regional approaches, with focused research programs engendering the necessary critical mass.

The basic “architecture” of such an agricultural R&D system in SSA is essentially in place—namely, CGIAR and other global research partners working with the SROs, in turn supporting the wide network of NARIs across the continent. Nevertheless, this so-called architecture has not yet coalesced into a fully interactive and integrated system with clear divisions of labor and effective subsidiarity. A significant reason for this is the underinvestment in national systems, together with maintenance of a wide scope of research programs, which reduces their effectiveness. National agricultural investment plans under CAADP have not solved this problem because agricultural R&D has not been given sufficient priority in such plans. A few “large” African countries do invest in agricultural R&D at a scale that allows them to spearhead new technologies; while they are critical in subregional
programs in providing centers of excellence, they do not replace the capacity needed in the “small” country programs to adapt such new technologies to local conditions. Increasing national agricultural R&D investment remains a critical prerequisite for achieving balanced agricultural growth in Africa.

**References**