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REPORT ON BOOSTING INVESTMENT IN AGRICULTURE RESEARCH IN AFRICA: BUILDING A CASE FOR INCREASED INVESTMENT IN AGRICULTURAL RESEARCH IN AFRICA

I. SUMMARY

Agricultural research and experimental development (R&D) investment is positively associated with high returns, but these returns take time—often decades—to develop. Consequently, the inherent lag from the inception of research to the adoption of new technologies calls for sustained and stable R&D funding. In 2016, Africa invested just 0.39 percent of its agricultural gross domestic product (AgGDP) in agricultural R&D, down from 0.54 percent in 2000. Furthermore, only a handful of African countries invest at least 1 percent of their AgGDP in agricultural research; the target set by New Partnership for Africa's Development (NEPAD). Even though in absolute terms total R&D investment has increased since the turn of the millennium—after a period of stagnation—most of the funds have been directed toward research staff expansion, salary increases, and rehabilitation of derelict research infrastructure and equipment, rather than actual research programs. In fact, in a large number of African countries, the national government funds the salaries of researchers and support staff, but little else, leaving nonsalary-related expenses highly dependent on donors and other funding sources.

Although African leaders recognize that agriculture is a critical engine for economic development, job creation, and poverty reduction, countries are still underinvesting considerably in agricultural research. Continued underinvestment will constrain long-term agricultural productivity growth and the capacity of countries to develop value chains, achieve self-sufficiency in a broader range of commodities, reduce poverty, and ensure food security. To address agricultural production challenges more effectively, governments need to substantially raise their agricultural research investment levels in the coming years, while donor funding needs to be better aligned with national and regional priorities. The private sector is still a relatively untapped source of funding for agricultural R&D. To provide much-needed higher and sustainable levels of funding into the future, innovative mechanisms need to be explored that tap into private funds for research on a broad range of commodities.

Funding for agricultural research not only needs to increase, but also be targeted more directly to priority areas. Given the relatively long lag between investing in research and reaping its benefits, the decisions countries make about the allocation of their agricultural research resources today will have profound implications on agricultural productivity for decades. Forward-looking projections can support countries in assessing the risks and potentials of different research investment scenarios, and in establishing long-term research priorities and investment allocations that align with national and regional development and innovation plans.

Economies of scale and scope are critical drivers behind the performance of agricultural R&D systems, emphasizing the critical importance of R&D collaboration and coordination among countries. Small countries generally record much lower returns to agricultural R&D compared to their larger counterparts, and their R&D efforts have been less effective in reducing poverty and malnutrition, two of Comprehensive Africa Agriculture Development Programme's (CAADP) main goals. Further integration of agricultural R&D at the regional and continental level is therefore essential, as it allows scarce R&D resources to be used more efficiently. It also allows countries with limited domestic research capacity to benefit from gains achieved in countries with more developed R&D systems. Continued support to regional bodies, networks, and mechanisms will further aid in defining, implementing, and funding a research agenda focused on issues of regional interest. Better coordination and a clear articulation of mandates and responsibilities among national, regional, continental, and global R&D players are key in ensuring that scarce R&D resources are optimized, research duplication minimized, and synergies and complementarities enhanced

II. BACKGROUND

II.1 Introduction and Policy Context

Agriculture is the single most important economic activity in Africa by far. The sector provides employment to roughly two-thirds of the continent's labor force and it contributes between 30 to 60 percent of African countries' gross domestic product (GDP), on average (FAO 2021, World Bank 2021). The vast majority of African farmers are smallholders. Productivity of these smallholder farms, however, is low compared to other developing regions, and this has perpetuated rural poverty throughout the continent. Rapid population growth, deteriorating soils, climate change, volatile food prices, and the recent COVID-19 pandemic are all adding further pressure on agricultural production and food security across Africa.

African leaders recognize that agriculture is a critical engine for economic development, job creation, and poverty reduction. In 2003, the African Union Commission (AUC) launched the Comprehensive Africa Agriculture Development Program (CAADP) that laid out a vision towards 6 percent annual growth of the agricultural sector and an allocation of at least 10 percent of public expenditures to agriculture. Through its Pillar IV, CAADP emphasized the essential role of agricultural research and experimental development (R&D), technology dissemination, and adoption. In 2014, the African Union (AU) member states reconfirmed their CAADP commitments by adopting the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. This Declaration provides direction to transform the agricultural sector within the broader CAADP framework and is an important vehicle to achieve the objectives of the First Ten Year Implementation Plan of Africa's Agenda 2063, which is an essential policy initiative that helps AU member states achieve agriculture-led growth, halving hunger and ending poverty by 2025, boosting intra-African trade in agricultural goods and services, enhancing resilience to climate variability, and increasing public and private investment in agriculture.

Across Africa, agricultural growth will be highly dependent on technological advancement to enable yield increases, more efficient use of scarce resources, and a reduction in crop losses. Investments in agricultural R&D are critical in this regard. Well-financed agricultural research and innovation systems enhance agricultural productivity and support sustainable agricultural growth and transformation in Africa, which in turn have an important impact on employment, stability, and peace. Extensive evidence indicates that agricultural R&D has had a tremendous impact on agricultural productivity around the world (World Bank 2007; IAASTD 2008, Fuglie et al. 2012). Despite this well-documented evidence, many African countries continue to underinvest in agricultural R&D. Given the substantial time lag between investing in research and reaping its rewards—which is typically decades, not just years—agricultural research requires a long-term commitment of sufficient levels of sustained funding.

Recognizing this, the AU Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) and the Science Agenda for Agriculture in Africa (S3A)—both of which are very closely aligned with CAADP and the Agenda 2063—have put agricultural science, technology, and innovation at the forefront of Africa's socio-economic development and growth.

Tracking, monitoring, and reporting on advancements towards achieving the CAADP and Malabo goals and targets are key to measuring progress over time and to holding countries accountable for delivering on their agricultural growth and transformation commitments. A Biennial Review (BR) process of the AUC evaluates country performance against 24 performance categories and 47 indicators. One of these indicators is *"total agricultural research spending as a share of AgGDP"*. The AU's New Partnership for Africa's Development (NEPAD), for instance, has set a target for government spending on *agricultural* R&D of at least 1 percent of *agricultural* GDP (AgGDP), in line with the 2007 AU Assembly commitment to allocate at least 1 percent of *overall* GDP to R&D (African Union 2007).

This synthesis report is a summary of a longer report[1] commissioned by the African Union's Semi-Arid Food Grain Research and Development (SAFGRAD) assessing trends in agricultural R&D investment in Africa over time, based on data from the Agricultural Science and Technology Indicators (ASTI) program.[2] It analyzes the continent's and individual countries' agricultural R&D intensity ratios. The report also assesses countries' agricultural R&D performance and provides various forward-looking investment scenarios that are based on different investment growth targets and it assesses the long-term impacts on agricultural productivity growth for each of these scenarios.

II.2 Institutional **Context of African Agricultural R&D**

With the exception of a handful of large countries like Egypt, Nigeria, and South Africa, and a number of mid-sized countries, most national agricultural research systems (NARS) in Africa are quite small, but they tend to focus their research on the same range of issues as their larger neighbors, thereby often exceeding the limits of their capacity. As a result, these smaller systems mostly conduct research focused on adapting technologies

[1] Add web link to report (on SAFGRAD and/or ASTI websites

[2] The Agricultural Science and Technology Indicators (ASTI) program of the International Food Policy Research Institute (IFPRI) collects, compiles, and disseminates information on financial, human, and institutional resources at both country and regional levels across government, higher education, nonprofit, and (where possible) private for-profit agricultural research agencies. ASTI's datasets are accessible on asti.cgiar.org through an array of user-friendly tools and publications.

developed elsewhere to meet their local needs. Spillovers of relevant technologies from larger neighboring countries tend to be limited because many of the small countries are clustered together. Most African NARSs are also heavily fragmented in terms of the number of individual agencies (often without well-defined research mandates) conducting R&D, and this has hindered the effective use of the available resources.

Although the share of the national agricultural research institutes' (NARIs) in national agricultural R&D has declined over time, they still anchor most NARS in Africa. The number of higher education agencies in many countries has grown over the time through the creation of new universities or new departments and faculties within existing universities. In general, the involvement of both for-profit and nonprofit private agencies in agricultural R&D remains limited in most countries, with the exception of South Africa.

African NARSs continue to face numerous challenges in terms of the scope and quality of their infrastructure, including poor (or lacking) laboratory space and equipment, farm equipment, vehicles, and funds for on-field research trials. Furthermore, many agencies face serious human resource capacity challenges. For example, a large number of agricultural researchers, especially those qualified to the PhD-level, are approaching retirement age, representing a significant risk that the affected agencies could be left without the critical mass of senior, well-experienced researchers needed to lead research programs. This trend, combined with high shares of more recently recruited junior staff in need of experience and mentoring, has left many countries vulnerable. Without adequate succession strategies and training, significant knowledge gaps will emerge, raising concerns about the quality of future research outputs.

Linkages between research agencies are often suboptimal due to the aforementioned fragmentation and a lack of coordination mechanisms. Linkages are also inadequate between agricultural research and extension providers caused by severe underinvestment in both sectors as well as frequent changes in extension modalities. Finally, agricultural research agencies are often poorly connected to other principal actors in the countries' agricultural innovation systems (AIS), including policymakers, farmers, traders, and processors. Strengthening such linkages will not only require advancement of innovative capacities and skill sets at the research agencies, but also the establishment of different institutional modalities such as innovation platforms and brokers (Roseboom and Flaherty 2016).

African agricultural research remains for the most part structured around geographic boundaries. However, given that many African countries share agro-ecological conditions, structuring agricultural research at the pan-African level around agro-ecosystems would make a lot of sense. This would reduce duplication of research effort and enhance the overall effectiveness and impact of agricultural R&D. Cross-country collaboration across NARSs and their integration into broader AIS is facilitated through four subregional organizations (SROs), the Forum for Agricultural Research in Africa (FARA),[3] CGIAR centers, and various other organizations and initiatives.

III. BODY / CONTEXT:

Trends in Long-Term Agricultural R&D Spending

Following a period of slow growth in the 1980s and 1990s, Africa's agricultural research spending—excluding the private for-profit sector—has increased since the turn of the millennium. This growth in investment, however, stemmed primarily from salary increases for research staff, rehabilitation of derelict research infrastructure and equipment (not in the least as part of large World Bank-funded initiatives), and stronger involvement in agricultural research activities by the higher education sector due to the sector's capacity expansion. Although these are important investments, they have not been complemented with additional allocations to basic and adaptive research programs. In many African countries, funding for actual R&D activities is extremely low and dangerously dependent on often volatile, external funding sources.

Recent ASTI data also demonstrates that the period of sustained growth in R&D spending since the turn of the millennium has ended, at least for the time being. Between 2014 and 2016 (the most recent year for which ASTI data were available for Africa), continentwide agricultural research stagnated. It is too premature to tell if this was an anomaly or an early sign of a longer-term trend. What is certain, however, is that spending declines were broad-based: Seventeen of the 35 countries in Africa south of the Sahara (SSA) for which long-term ASTI time series data were available reported cuts in their agricultural R&D expenditures over the 2014–2016 period. This raises important concerns, given the multitude of challenges the African agricultural sector is facing.

In 2016, the continent as a whole spent $3.4 billion on agricultural research, in 2011 PPP prices.[4] Spending is heavily concentrated in some of the larger countries (Figure 1). Egypt ($682 million), Nigeria ($445 million), and South Africa ($346 million) combined accounted for 44 percent of continentwide agricultural research spending. Kenya is the fourth largest country in terms of agricultural research expenditures ($222 million in 2016), followed by Morocco ($187 million), Ghana ($179 million), Ethiopia ($162 million), and Algeria ($124 million).[5] Spending levels of the remaining countries were considerably lower. Seven countries (Uganda, Côte d'Ivoire, Tunisia, Tanzania, Cameroon, Mali, and

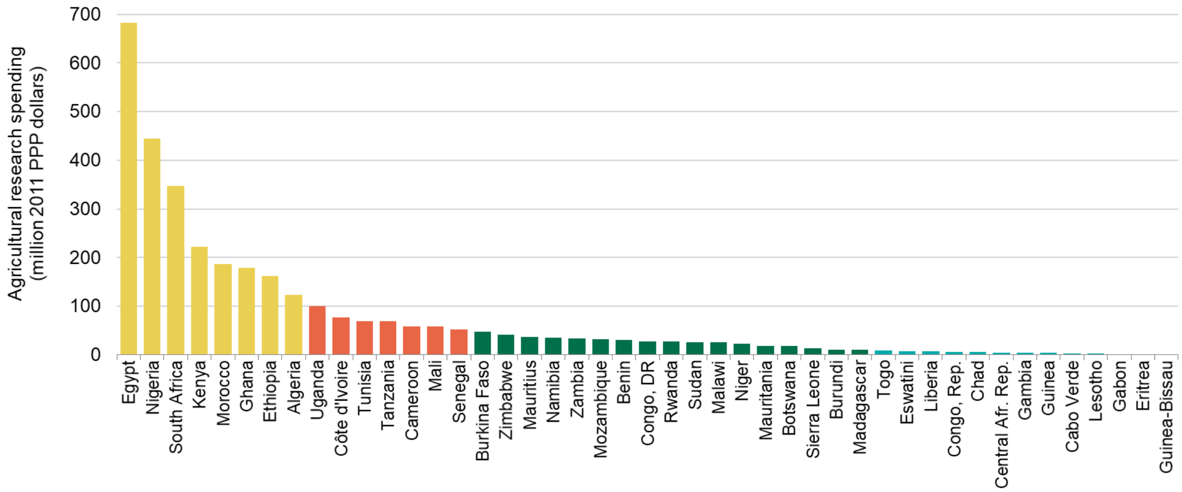
[3] The SROs and FARA—all of which are highly dependent on unstable donor funding—do not conduct research themselves, but instead promote the conduct of regionally beneficial agricultural research and innovation by their members. They also attempt to strengthen coordination and collaboration among NARIs.

[4] Agricultural research investment data in this report include government, higher education, and nonprofit agencies that conduct agricultural research. The private for-profit sector is excluded because data for the majority of private firms are not accessible. Purchasing power parities (PPPs) measure the relative purchasing power of currencies across countries by eliminating national differences in pricing levels for a wide range of goods and services.

[5] 2016 data for Algeria, Egypt, Morocco, and Tunisia was estimated based on these countries' expenditure data for 2012, and assuming that spending growth followed growth in these countries' AgGDP during 2012–2016.

Senegal) spent between $50 and $100 million on agricultural research; 18 countries between $10 and $50 million; and 17 countries between $0.2 and $10 million.

Figure 1—Agricultural research spending by country, 2016

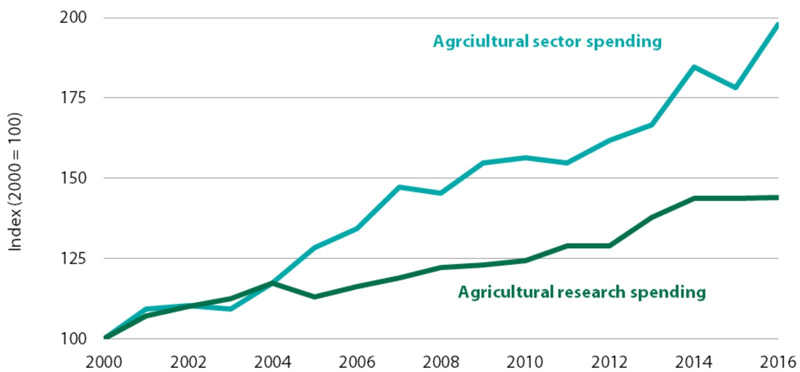


Source: Calculated by authors based on ASTI data (various years).
Notes: Totals exclude the private for-profit sector. Data for Angola, Comoros, Djibouti, Equatorial Guinea, Libya, São Tomé and Príncipe, Seychelles, Somalia, and South Sudan were unavailable and have been excluded. Values for Guinea-Bissau, Eritrea, Liberia, and Sudan are based on 2011 data; values for Algeria, Egypt, Morocco, and Tunisia on 2012 data; values for Burkina Faso and Malawi on 214 data; and values for South Africa on 2015 data. The values for Nigeria, Sierra Leone, and South Africa include estimates for the higher education sector.

The allocation of research budgets across salaries, operating costs, and capital investments has an important impact on the effectiveness and efficiency of agricultural research. A breakdown of spending during 2009–2016 by cost category reveals important differences across countries. Based on a sample encompassing the principal government agencies of 35 SSA countries for which detailed cost category data were available, about half of the available finances was spent on staff salaries, close to 40 percent on operating and program costs, and the remaining 11 percent was invested in capital improvements. These regional averages mask a significant degree of cross-country variation, which can, to a certain extent, be explained by an institute's dependency on donor funding that is typically allocated to nonsalary-related cost such as the rehabilitation of research infrastructure or the cost of research programs.

The 2003 launch of CAADP elevated agriculture within Africa's political agenda. Although a large number of African countries have yet to attain CAADP's ambitious targets (i.e., spending at least 10 percent of their national budgets on agriculture in order to ensure 6 percent sectoral growth per year), substantial progress has been made over time. Investments in agriculture accelerated quickly after 2003, following a long period of neglect in prior decades (Figure 2). During 2000–2016, Africa doubled its agricultural sector spending (in inflation-adjusted terms). Agricultural research spending also grew during this timeframe, albeit at a considerably slower rate (44 percent during 2000–2016). The data thus indicate that, although many African countries have increased their investments in areas such as farm support and subsidies, training, and irrigation, levels of investment in agricultural research have seriously trailed.

Figure 2—Spending on agriculture and on agricultural research in Africa, 2000–2016



Sources: Data on agricultural spending are from ReSAKSS (2021); data on agricultural research spending are from ASTI (various years).
Note: Agricultural spending only includes funds derived from national governments; agricultural research spending includes funds derived from governments, donors, development banks, producer organizations, and revenues generated internally by research agencies.

Analysis of R&D Funding Sources

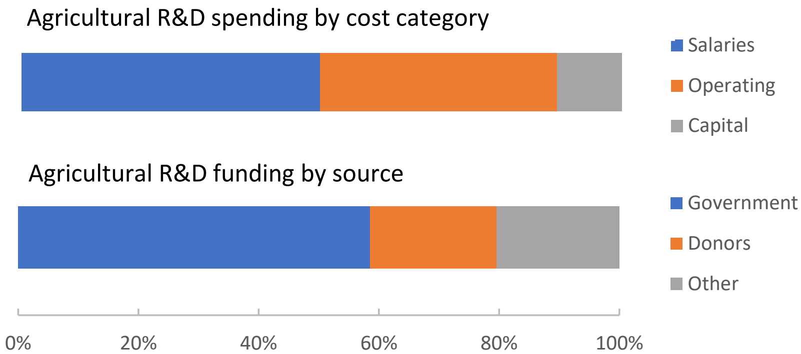
A complete analysis of yearly agricultural research investment levels across countries also requires an examination of how agricultural research is funded. In some countries, the national government funds the bulk of agricultural research activities undertaken by NARIs, whereas other countries are extremely dependent on outside funding from donors and development banks. In certain countries, research agencies generate substantial amounts of funding internally by selling goods (such as seed and vaccinations) and services (such as laboratory tests and technical assistance), while in other countries, the proceeds of such sales are channeled back to the national treasury, discouraging agencies from pursuing this revenue stream. Several countries, including Côte d'Ivoire,[6]

[6] Côte d'Ivoire's National Center for Agricultural Research (CNRA) stands out in that it is predominantly funded by private producers through the Inter-Professional Fund for Agricultural Research and Extension (FIRCA). FIRCA allocates at least 75 percent of the subscription fees raised by producers in a given subsector to research serving that commodity. The remaining funds are allocated to a solidarity fund to serve sectors (mostly food crops) unable to raise sufficient funding through their own subscription fees. FIRCA is unique and exemplary in Africa in that it promotes demand-driven research.

Kenya, and Tanzania, have established funding systems that mobilize private-sector resources, either via a tax levy or through subscription dues.

Agricultural research in SSA is far more dependent on donor and development bank funding compared with other developing regions around the world, including North Africa (Stads 2015; Stads 2016). Overall, during 2009–2016, 57 percent of the funding to the NARIs in SSA (excluding Nigeria, South Africa, and a number of the smaller countries) was provided by national governments, and funding from donors and development banks constituted 28 percent.[7] Dependency on donor funding is particularly high among francophone West African countries. In a large number of countries, the national government funds the salaries of researchers and support staff, but little else, leaving nonsalary-related expenses highly dependent on donors and other funding sources (Figure 3). Although many governments are committed to funding agricultural research in principle, the amounts disbursed are routinely lower than—and in some cases only a fraction of—budgeted allocations. It goes without saying that these funding discrepancies have severe repercussions on the day-to-day operations of agricultural research agencies and their planned activities.

Figure 3—Breakdown of agricultural R&D spending and funding in SSA, 2009–2016 average



Source: Calculated by authors based on ASTI data (various years).
Note: The category *other* includes commodity levies, the sale of goods and services, and other funding sources.

Funding from donors and development banks has shown considerably greater volatility over the past decade compared with government funding. In a large number of SSA countries, donors fund the bulk of nonsalary-related expenditures—that is, program and operating costs and capital investment and there is extensive evidence of agencies reverting to financial crisis upon the completion of large donor-funded projects, forcing them to scale back their activities. Too much of the critical decision making about research

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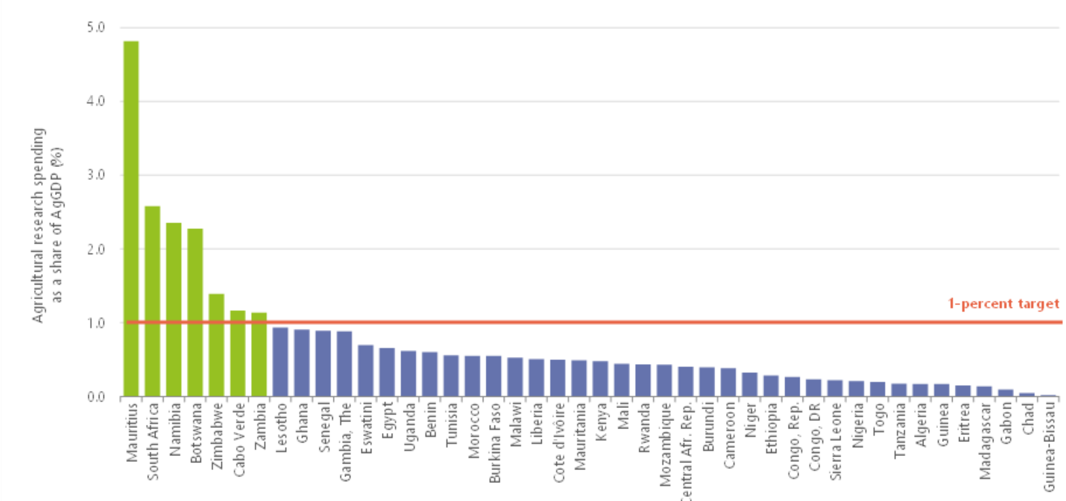
[7] The World Bank has been a major contributor to the institutional development of agricultural research in SSA in the form of country-level projects financed through loans and supplemented by grants. Projects have variously focused purely on agricultural research (the more common approach in the 1980s and 1990s) or on agriculture more generally, while including an agricultural research component (the more common approach in the 2000s).

priorities appears to be devolved to donors, with the result that the research agendas of many agricultural research agencies across SSA—particularly in smaller, low-income countries—can be skewed either toward short-term goals that are not necessarily aligned with national and (sub)regional priorities or to commodities of comparatively limited economic importance. A new framework is therefore needed whereby governments establish strategic priorities that donors contribute to.[8] Furthermore, severe fluctuations in yearly agricultural research funding significantly complicate and compromise long-term budget, staffing, and planning decisions, all of which affect the continuity and outcomes of research such as the release of new varieties and technologies. This will in the long run, in turn negatively affecting agricultural productivity growth and poverty reduction.

Agricultural R&D Intensity Ratios

Growth in spending on agricultural research has also been slower than growth in agricultural output over time. As a result, Africa's agricultural research intensity ratio—that is, its agricultural research spending as a percentage of AgGDP—dropped markedly, from 0.54 percent in 2000 to just 0.39 percent in 2016. In 2016, 37 of the 44 African countries for which data were available invested less than 1 percent of their AgGDP in agricultural research (Figure 4), thereby falling short of the minimum investment target set by NEPAD. In fact, 24 of these 44 countries spent less than 0.5 percent of their AgGDP. Mauritius, South Africa, Namibia, Botswana, Zambia, and Zimbabwe all reached the 1-percent target in 2016. Cabo Verde was the only country outside the Southern African subregion to spend more than 1 percent of its AgGDP on agricultural R&D.[9]

Figure 4—African agricultural research spending as a share of agricultural GDP, 2000–2016



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[8] This is already taking place in countries like Nigeria and Tanzania through Project Coordination Units (PCUs) within the Ministry of Agriculture. However, more national governments need to be making critical investments in support of research implementation beyond paying staff salaries.

[9] It is important to note that the 2016 intensity ratios based on ASTI data can differ substantially from those tracked by the countries themselves as part of the BR process (African Union 2019). The differences are presumably due to variations in reporting year, definitions, methodology, and agency coverage.

Sources: Calculated by authors based on ASTI data (various years); data on AgGDP are from World Bank (2021).
Notes: See Figure 1.

Although intensity ratios provide useful insights into relative investment levels across countries and over time, they fail to take into account the policy and institutional environment within which agricultural research occurs, the broader size and structure of a country's agricultural sector and economy, or qualitative differences in research performance across countries. For these reasons they need to be interpreted carefully, within the context of national circumstances. A one-size-fits-all investment target for the region as a whole is not desirable given that structural economic differences call for different investment strategies. For example, small countries often have higher intensity ratios based on an inability to take advantage of economies of scale. To be effective, national research systems in small countries need to establish minimum-level capacities across relevant disciplines and major commodities, regardless of the size of the agricultural sector they serve. Establishing this critical mass generally means spending more on agricultural research relative to larger countries to achieve the same. The smaller the country's AgGDP, the higher its agricultural R&D intensity ratio. Relatedly, an increase of a country's agricultural research intensity ratio over time can actually reflect reduced agricultural output rather than higher investment. Finally, a case can be made that AgGDP levels only partially indicate the importance of agriculture to a national economy. For example, more advanced economies invest significantly in research on agrochemicals and food processing, but these fields are not classified as "agriculture" under official definitions and hence are not reflected in these countries' intensity ratios.

Performance of Agricultural R&D Systems

Instead of the one-size-fits-all investment target of 1 percent of AgGDP for all African countries, an alternative approach is to consider a broader set of structural characteristics affecting a country's commitment and capacity to invest in agricultural R&D beyond just the size of its agricultural sector.[10] This more holistic approach considers other elements that affect the performance of the R&D system:

- size of the NARS, which determines its overall performance, affecting costs, productivity, and outputs;
- quality and productivity of human capital, measured by qualification levels of and research output by researcher;
- allocation of spending by cost category, acknowledging that evidence suggests that higher human capital and productivity are positively correlated with salaries and operating costs and both are negatively correlated with capital costs;
- research outputs in terms of scientific and technological innovations; and

[10] This alternative follows the conceptual framework of Guan and Chen (2012), where an innovation production activity is seen as the process of converting knowledge and ideas into benefit value.

- linkages between the NARS and other components of the AIS and the external environment (given that a system's overall performance is to an important extent determined by structural socio-economic and/or exogenous variables).

For each of these elements, indicators were applied to rank African countries based on their performance in that particular area and were then classified into three groups: i) worst performers; ii) average performers; and iii) best performers.[11]

The analysis reveals that one of the major drivers of performance is the size of the research system (measured by annual R&D investment). Agricultural R&D systems that spend less than $40 million per year (in 2011 PPP prices) are highly inefficient both in terms of cost per unit of output and in productivity of researchers. Productivity (measured by publications per researcher) is more than double in countries spending between $40 and $100 million per year, compared to countries spending less than $40 million per year, while their costs per publication are about 30 percent lower. This is important because only 15 countries in Africa have research systems that spend more than $40 million per year. The numbers thus suggest that economies of scale and scope are critical drivers behind the overall performance of agricultural R&D systems, which once again emphasizes the crucial importance of R&D collaboration and coordination among countries.

Future Investment Scenarios

Analyzing the past performance of agricultural research systems is useful for identifying systems' strengths and weaknesses and detecting areas needing improvement, but will not prepare a NARS for its future challenges and opportunities. In the next 20 to 30 years, African economies will continue to grow, incomes will increase, and consumption patterns will change, as will the demand for agricultural products, imports, and exports. In this context, forward-looking scenario models are useful for assessing the risks and potentials of different portfolios of agricultural research investment.

A *business-as-usual* scenario, under which agricultural R&D investment and production inputs (capital, land, labor) continue to grow at historical rates, will not result in achieving the ambitious CAADP target of 6 percent annual agricultural GDP growth by 2030.[12] Even if Africa manages to triple its agricultural R&D investment by 2030, the ambitious CAADP target will not be reached. Instead, achieving 6-percent agricultural sector growth will require a combination of increased investment in mechanization, irrigation, and animal stock as well as greater R&D spending in areas with potential to maximize benefits of available technologies. At the same time, and given the lagged effects of research, there is a need to boost investment in R&D to sustain agricultural GDP growth above 5 percent after 2030 and the productivity of growing capital in agriculture. Increasing African R&D investment at these high levels is probably not feasible at present, but increasing the efficiency of research systems through improved allocation of resources within and

[11] See the longer report (add link) for a full explanation of the methodology, list of indicators, and main findings for each indicator and performance group.

[12] See the longer report (add link) for a full explanation of the methodology.

between countries should enhance the efficiency and impact of R&D investment. The overall growth rate of agricultural R&D investment is not the only element that matters, however. With limited financial resources stretched along dozens of different commodities and scientific specialties, it is also very important to draw attention to the returns of R&D on specific commodities and how different research priorities affect future productivity.

IV. CONCLUSION AND RECOMMENDATIONS

Well-developed national agricultural research systems and adequate levels of investment and human resource capacities are prerequisites in the attainment of agricultural development, food security, and poverty reduction. Nonetheless, Africa is still underinvesting considerably in agricultural R&D despite increased political support for the agricultural sector through CAADP. Even though total R&D investment has increased since the turn of the millennium, countries have directed most of the funds toward (much-needed) salary increases for research staff, rather than actual research programs. In a large number of countries, the national government funds the salaries of researchers and support staff, but little else, leaving nonsalary-related expenses highly dependent on donors and other funding sources. Governments urgently need to address underinvestment in agricultural R&D and ensure the full disbursement of approved budgets. They must provide stable and sustainable levels of funding to secure a strategic program of effective research activities that yields increased agricultural productivity. Rather than relying too much on donor contributions and development bank loans to fund critical areas of research, (national and regional) governments need to determine their own long-term national priorities and design relevant, focused, and coherent agricultural R&D programs accordingly. Donor and development bank funding needs to synergistically complement these priorities. Mitigating the effects of any single donor's abrupt change in aid disbursement is crucial, highlighting the need for greater funding diversification—for example, through the sale of goods and services, or by attracting complementary investment from the private sector. The private sector is currently the least developed source of sustainable financing for agricultural R&D in Africa (its funding potential remains largely untapped in most countries). Cultivating private funding requires that national governments provide a more enabling policy environment through tax incentives, protection of intellectual property rights, and regulatory reforms to encourage the spill-in of international technology. More innovative R&D funding mechanisms need to be explored by a greater number of countries.

Growing concern exists regarding the lack of human resource capacity in agricultural R&D to respond effectively to the challenges that the African agricultural sector is facing. NARIs therefore need to develop systematic human resource strategies without delay, incorporating existing and anticipated skills gaps and training needs. These should also include incentives to create a more conducive work environment for agricultural researchers is crucial to attract, retain, and motivate well-qualified researchers. The successful implementation of such strategies will require both political and financial support. National governments must expand their investments in agricultural higher education to allow universities to increase the number and size of their graduate programs and to improve the curricula of existing programs.

Agricultural research investment is positively associated with high returns, but these returns take time—often decades—to accrue. Consequently, the inherent lag from the inception of research to the adoption of new varieties or technologies calls for sufficient and sustained agricultural research funding. Nonetheless, agriculture in Africa continues to be challenged by production inefficiencies resulting from a mostly traditional production system, natural resource depletion, climate change and variability, and environmental degradation, all of which emphasize the need for considerably higher levels of sustained agricultural research investment in the coming decades.

Repeated calls have been made for increased investments in Africa's agricultural research (and the wider innovation) systems through CAADP, STISA-24, and S3A. AUC actively monitors the advancements towards achieving the CAADP and Malabo goals through its BR process. One of the indicators that AUC actively tracks is whether countries invest at least 1 percent of their AgGDP in agricultural research but only a handful of (mostly Southern) African countries have been able to reach this target. However, a one-size-fits-all intensity target of 1 percent for all African countries is undesirable, given the widely diverging structural characteristics of each country's economy and agricultural sector. Rather than setting one-size-fits-all national investment targets, it is probably more meaningful to assess investment capacity and allocation for Africa as a whole and set (sub-) regional R&D investment targets.

Regardless of the indicator used to assess agricultural R&D investment, Africa needs to substantially raise its level of agricultural R&D investment to address its agricultural production challenges more effectively. Continued underinvestment will constrain long-term agricultural productivity growth and the capacity of countries to develop value chains, achieve self-sufficiency in a broader range of commodities, reduce poverty, and ensure food security, all of which are important CAADP goals. Even though most research systems in the region are severely challenged by low efficiency and high costs, the situation is more severe among Africa's smaller countries.

African agricultural research remains for the most part structured around geographic boundaries. However, given that many African countries share agro-ecological conditions, structuring agricultural research at the pan-African level around agro-ecosystems would make a lot of sense. Consequently, a closer integration of agricultural R&D at the subregional and regional level (through joint research programs and regional centers of excellence) is indispensable, as it allows countries with lagging agricultural research systems to benefit from the gains made in countries with similar agro-ecological conditions that have more advanced systems. Continued support to and growth of regional bodies, networks, and mechanisms (including One CGIAR) will reduce duplication of research effort, will help effectively define, implement, and fund regional research agendas targeting issues of common interest, and will ultimately produce higher research impact.

1. While investments in agricultural research undoubtedly need to increase considerably, optimizing the use of agricultural research resources across countries is certainly a sensible strategy as well. Taking into account where an additional dollar has the largest impact, priority should be given to investment in NARSs in countries with large agricultural sectors, cross-country collaborative research, and the CGIAR. This certainly does not mean that local adaptive research should be deprioritized (it is needed to exploit the benefits of more upstream research), but only that the potential returns to such research are generally lower. To sum up, better coordination and a clear articulation of mandates and responsibilities among national, subregional, regional, and global R&D players are essential to ensuring that scarce financial, human, and infrastructure resources are optimized, duplications minimized, and synergies and complementarities enhanced