THE MAGIC OF CGIAR RESEARCH:
HARVESTING $10 FROM EVERY $1 INVESTED

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SoAR FOUNDATION

FOREWORD

The Supporters of Agricultural Research (SoAR) Foundation is an advocacy organization dedicated to increasing the quality and quantity of public agriculture research, which provides innovations to farmers and producers to help them be successful, meet global demand for food, and protect limited natural resources. SoAR commissioned The Payoff to Investing in CGIAR Research report to examine the benefit-cost ratio of CGIAR, the world's largest global agricultural research network. This provides an economic investment case for funding partners as they consider future investments in international agriculture research and development (R&D).

Established almost fifty years ago, CGIAR is currently composed of fifteen Research Centers working under a One CGIAR mandate to reduce poverty, enhance food and nutrition security, and improve natural resources. With a strong presence and long-term partnerships in developing countries, CGIAR is uniquely positioned to further create and develop needed innovations. CGIAR's early work included developing high-yielding wheat and rice varieties, which is credited with spurring the Green Revolution and saving a billion lives primarily in Asia where many people were on the brink of starvation. Today, CGIAR focuses on ending hunger by 2030 through science to transform food, land, and water systems in the climate crisis.

The Payoff to Investing in CGIAR Research found investments of roughly $60 billion in CGIAR in present value terms has generated a benefit-cost ratio of 10 to 1 over the past five decades. CGIAR's work to improve crop varieties, manage natural resources, and develop important policy recommendations have made significant contributions to reducing hunger and malnutrition. This has also resulted in economic gains, particularly for the world's poor.

The analysis also found that international agriculture research remains severely underfunded despite these high rates of return on investment. Not all governments, multilateral organizations, and international philanthropic organizations have sustained their investments in public agriculture R&D, both domestically and through CGIAR. Many low-income countries, particularly in sub-Saharan Africa, are losing ground in their efforts to apply science and technology to agricultural challenges, including climate change. COVID-19 could further reduce government spending on agricultural R&D given lower government budgets over the next few years (World Bank 2020).

Why does this matter? Because agricultural challenges are becoming more complex requiring more global collaboration and investment. Global food production needs to increase significantly over the next forty years

to meet growing demand. At the same time, agriculture everywhere is being negatively impacted by climate change. Farmers need access to new tools and technologies to adapt while protecting soil, land, water, and natural ecosystems.

Over time, breakthroughs in agriculture research have improved the quantity and quality of food production, and reduced poverty, hunger, and malnutrition around the world, especially in parts of Asia. However, global hunger is on the rise after decades of progress. The latest edition of the State of Food Security and Nutrition in the World (SOFI), published in July 2020, estimates that almost 690 million people were undernourished in 2019—an increase of 60 million over the last five years following decades of decline.

These numbers do not include the increase in hunger expected as a result of the COVID-19 pandemic, which could force as many as 130 million more people into chronic hunger by the end of 2020. Though the pandemic is expected to eventually subside, many underlying forces that have caused hunger to increase —climate stress, conflict, rising populations, pests, diseases, and macroeconomic challenges—are likely to intensify.

The dramatic total hunger numbers do not provide the full picture. In Africa, home

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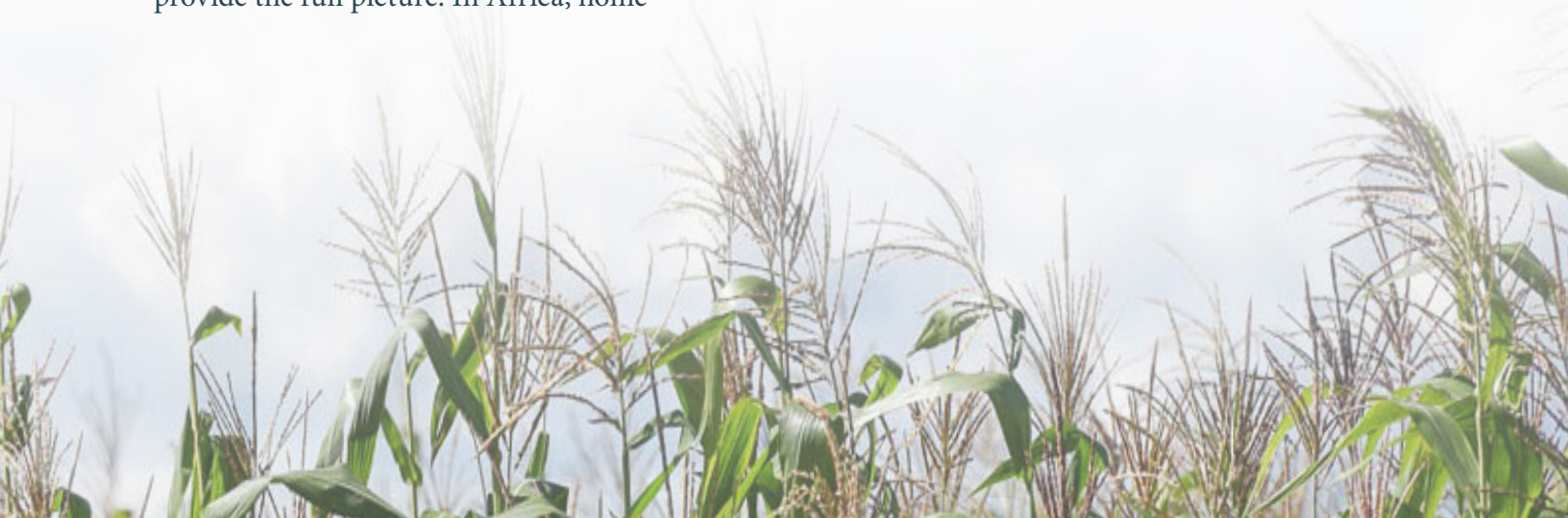
of the world's fastest growing population, the SOFI report found hunger now affects 19.1 percent of the population, up from 17.6 percent in 2014. If current trends hold, hunger will affect about a quarter of all Africans by 2030. Africa's absolute hunger numbers will rise from 250 million people to 433 million, overtaking Asia as the region with the highest number of undernourished. and accounting for half of the world's total.

The world's regions experiencing both the highest rates and most rapid rise in hunger are located where the majority of people depend on agriculture for their livelihoods. For example, up to 98 percent of rural households in many African countries engage in food production, mostly on smallholder farms with land holdings of less than a few acres or hectares.



Scaling up investments in international agriculture R&D is crucial to transform poorly performing agriculture sectors in places where hunger is rising, agriculture is the predominant economic activity, and intense food-related problems are a primary outcome of external shocks like extreme weather. All these factors will affect food production long after the pandemic has subsided.

Today, there is a measure of hope that the shock administered to food systems in low-income countries by the COVID-19 pandemic will also shock the global community into action. CGIAR Research Centers' quick responses was illustrative of their strong capabilities. This work has included setting up an early warning system for detecting food price spikes, tracking policy developments across 26 countries that impact food security, and using their livestock veterinary research laboratories to assist countries in COVID-19 testing and epidemiological tracking. CGIAR is also readying new interventions to accelerate recovery from the pandemic for rural and urban smallholder farmers who can play decisive roles in easing food shortages.

To help farmers adapt to climate change, CGIAR Research Centers and Programs are intensely focused on sustainable farming practices and providing farmers with access to a wider assortment of nutritious, climate-smart crop varieties. However, current R&D investments are not adequate for the complexities of contemporary food production challenges.

SoAR's report makes clear that the world has built a strong international agricultural R&D research infrastructure. Additional investments in CGIAR research would continue to yield dramatic returns on investment and benefits for poor communities, particularly in Africa and South Asia where smallholder farmers and local food systems are most vulnerable. With a strong presence and long-term partnerships in developing countries, CGIAR is uniquely positioned to further create and develop needed innovations.

KEY FINDINGS

In round figures, over the past five decades the CGIAR has spent about **$60 billion** in present value terms. This investment—mainly through its contributions to enhancing yields of staple food crops—has returned tenfold benefits (i.e., a benefit-cost ratio of 10:1), manifest as less-easily measured payoffs for poor people from greater food abundance, cheaper food, reduced rates of hunger and poverty, and a smaller geographical footprint of agriculture. This does not count substantial benefits accruing in high-income countries.

What Motivated Us

The CGIAR and its precursor centers were conceived to play a critical role, working in concert with the national agricultural research systems (NARSs) in low- and middle-income countries, to develop farm technologies that would help stave off a global food crisis. They succeeded. But the issues persist, and new challenges have emerged. Many commentators express concerns about the ability of the NARSs in low-income countries, especially in Africa, to meet food security targets while also addressing the global environmental agenda confronting agriculture. The CGIAR could potentially play a pivotal role in supporting that effort. Against this background, we sought to provide a hard-nosed assessment of the past payoffs to CGIAR research investments to help guide decisions regarding future funding.

What We Did

- To begin, we provided a detailed quantitative context for a review of the payoffs to investments in the CGIAR over the past five decades. We juxtaposed the CGIAR's institutional and investment history against the rapidly evolving investment realities in agricultural R&D and the shifting structure of agricultural production, worldwide. We showed:
  - The increase from four to fifteen (and with recent mergers, now effectively thirteen) centers contributed to a commensurate expansion in the scope of science and subject matter covered.
  - In the 1970s and 1980s, funding for agricultural R&D by high-income countries grew rapidly, and these countries provided the bulk of funding for the CGIAR.

- In recent decades, high-income countries have scaled back their support for both national public agricultural R&D and international agricultural research.
    - In the context of rising global investments in agricultural R&D, total funding for the CGIAR peaked at over $1 billion (2016 dollar values) in 2014 after a surge in response to the global food crisis.
    - Since 2014, total inflation-adjusted funding for the CGIAR fell rapidly to around $800 million in 2018.
    - The share of unencumbered funding shrank from around 80% in 1971 to 50% in 2000, and since 2010 has plummeted to very low levels.
    - Concerns have begun to emerge about the capacity of the world to sustainably reduce global hunger and poverty over the coming decades, and about the ability of the NARSs in developing countries, working in concert with the CGIAR, to provide the requisite technologies.

- To assess the payoffs to CGIAR spending we used money-metric measures: in particular, the benefit-cost ratio (BCR) and dollar-denominated measures of total benefits.
    - These money-metric measures are explicitly conceived as indications of the economic welfare consequences of R&D and are widely used for that purpose.
    - The BCR is an indicator of value for money, which is important both to investors and to those who manage research.

- We did not document evidence of other consequences of CGIAR research spending, such as effects on poverty rates.
    - Money-metric measures of total benefits could in principle be applied to specific groups (such as the poor), but distributional impacts were not the focus of this review and typically are not the focus of research evaluation reports.
    - Since the main beneficiaries from improvements in technology for staple crops are the producers and consumers of those crops, the lion's share of the total benefits from CGIAR crop-improvement research has gone to the poor.
    - Reports of other income and economic development consequences of agricultural R&D are less abundant, have been less scrutinized, and are open to greater skepticism and stronger concerns over attribution—perhaps especially for the part of that R&D conducted by the CGIAR.

- We employed three complementary approaches to assess the research payoffs:
  - We compiled the largest set to date of studies with comparable estimates of returns to CGIAR research and to public research undertaken by low- and middle-income countries.
  - We derived standardized measures of BCRs from most of those studies.
  - We analyzed results from studies that reported total payoffs to probe whether a subset of research activities with documented high payoffs could justify investments in the CGIAR as a whole, including spending on some research and other CGIAR activities for which benefits are not documented.
  - We estimated the aggregate value of total factor productivity growth—a widely accepted first-order approximation to money-metric measures of social benefits—for 1961–2020.
    - We attributed various portions of the incremental value to research by public agencies in developing countries and CGIAR.
    - We compared the measure of benefits with the cumulative aggregate costs of research over the period.

What We Found

- CGIAR research has been intensively evaluated, compared with its share of R&D spending:
  - 440 estimates of BCRs or IRRs (internal rates of return) per billion dollars of CGIAR spending in 2015 (2016 dollar values).
  - 47 estimates of BCRs or IRRs per billion dollars of public agricultural R&D spending in developing countries in 2015 (2016 dollar values).
  - 63 estimates of BCRs or IRRs per billion dollars of public agricultural R&D spending worldwide in 2015 (2016 dollar values).
- Our meta-analysis yields a median estimated BCR of approximately 10:1 for both CGIAR and developing-country NARS research; that is, on average, a dollar invested today brings a future return equivalent in (present) value to ten dollars today. This is a high BCR: any ratio over the threshold of 1:1 justifies investment.

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- We projected estimates of benefits from nine research evaluation projects (all related to high-payoff crop varietal changes) to 2020, summed them and compared the total against costs of CGIAR research carried out in concert with NARSs.
  - In 2016 present value terms, the estimated benefits across these nine projects (1966–2020) sum to $1,783 billion (2016 dollar values), all accruing in developing countries, home to the preponderance of the world's food poor.
  - In 2016 present value terms, the costs of the entire CGIAR portfolio over the period 1960–2010 was $59.7 billion (2016 dollar values).
  - If we attribute just one-quarter of the benefits reported in the nine high-payoff projects to the CGIAR (with the remainder to national partners and others), the BCR is 7.5:1; if we count only the costs of the CGIAR centers that conducted the relevant R&D, the BCR is 10:1.
- If one-half the value of all the reported agricultural TFP growth from 1960–2016 in developing countries is taken as a measure of the benefit from research investments by both CGIAR and public agencies in developing countries, a BCR on the order of 10:1 is implied for research by the CGIAR and national partners combined.

Credit: S. Modela (USDA)

Implications of our Findings

- Agricultural research is slow magic. Returns accrue over long periods—decades—and realizing the full potential from agricultural R&D requires far-sighted investments. It is also a cumulative endeavor, best done with steady and sustained investments.

- The evidence we assembled and examined shows that in agricultural R&D persistence and patience are well rewarded. Past investments in agricultural research, both by the CGIAR and by public agencies in low-and middle-income countries, have yielded very high returns.

- This does not count the spillover benefits to high-income countries, including donor countries "doing well by doing good" (Tribe 1991). Pardey et al. (1996) estimated substantial benefits attributable to CGIAR breeders from adoption of improved wheat and rice varieties in the United States, based on releases from CGIAR centers, sufficient to cover all costs of the entire CGIAR system. Likewise, Brennan (1989) and Brennan and Fox (1995) found large impacts in Australia from adoption of CGIAR-based wheat varieties.

- These findings mean that national governments and development partners have persistently underinvested in the enterprise at home and abroad.

    - A BCR significantly greater than 1:1 indicates that governments would have profited society by doing more agricultural R&D, compared with investment opportunities normally available to them.

    - A BCR of 10:1 indicates that agricultural R&D was clearly more profitable than almost any other government investment.

    - Opportunities for investment in other national and global public goods (like education and infrastructure) might also have yielded very high returns, but comparable (and comparably strong and abundant) evidence is not available to support a claim that those other opportunities yielded BCRs in the range of 10:1.

- That the BCRs for CGIAR and non-CGIAR research are of similar magnitudes, and not statistically distinguishable, does not imply that funding for internationally conceived R&D could be reduced or replaced by investment in the NARSs.

    - The unique position of the CGIAR allows it to leverage R&D capacity in middle- and high-income countries for the benefit of low-income countries.

        - Internationally conceived R&D outputs and services complement those produced in NARSs.

    - CGIAR centers have comparative advantage in developing broadly applicable agricultural technologies.

  - The measures of payoffs to CGIAR R&D typically reflect the consequences of R&D conducted jointly with NARS partners.

  - Internationally conceived R&D explicitly addresses high-potential gaps in NARS research—often multinational or global public goods.

- The totality of the evidence in this report and elsewhere (see, e.g., Pardey and Alston 2011; Fuglie and Heisey 2007) supports at least doubling the total public investment in agricultural R&D performed by both national and international agencies.

  - The past benefits have been many times larger than the investments that generated them.

  - Allowing suitable time to economically expand capacity, we see ample scope for reinvesting a modest fraction of the surplus generated by past R&D to generate comparably large future net benefits.

  - We see no evidence of diminishing returns and a strong case for investing in the global public good of preparedness to meet expanding demands for new technologies to serve the world's food poor and to mitigate the ongoing (and arguably increasing) challenges to global food supplies and farmer livelihoods posed by weather, pests, political strife, policy risk and market risk.

- Recent trends and geopolitical patterns in research investment are troubling:
  - High-income countries have scaled back their investments in agricultural R&D, both at home and through the CGIAR.
  - Although middle-income countries have developed national capacity in agricultural research, the same is not true for many low-income countries still heavily dependent on agriculture for livelihoods and food security.
  - In particular, research investment in sub-Saharan Africa lags significantly, and the gap has grown over time.
- Some African governments are losing ground in their efforts to apply science and technology to current and future agricultural challenges, including climate change:
  - One-third of the NARSs spent less in 2015 than in 2000, after adjustment for inflation.
- The focus of CGIAR research has appropriately shifted toward low capacity, low-income countries, and partnerships there are still much needed.
- The CGIAR funding model still depends crucially on allocations from a small group of national governments and private foundations mostly in high-income countries.
- Many agriculturally large middle-income countries have yet to contribute significantly to funding the CGIAR.