Global Food Security and Climate Change Mitigation: The Potential Role of the Consultative Group on International Agricultural Research

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Key Points

- Population growth, shifting diets, and increases in the use of food crops for industrial purposes such as biofuels and animal feed are colliding with the reality that the agricultural sector needs to achieve reductions in greenhouse gas emissions and make efficient use of land and water resources to mitigate future food and climate crises.
- While many investments and initiatives have limited impact, investments in agricultural research and development by the Consultative Group on International Agricultural Research (CGIAR) have yielded benefits worth 10 times their costs.
- The CGIAR should focus on achieving genetic gains for higher crop yields and productivity, designing resilient farm systems, and modifying policies that incentivize inefficient agricultural practices while improving climate and nutrition outcomes, considering localized agroclimatic conditions, and ensuring programs are available to small farmers.

The world is not on track to achieve the United Nations's Sustainable Development "Goal 2.1" of ending hunger by 2030 or the Paris agreement target of stabilizing global warming at below 2°C above preindustrial levels.[1] To improve global food security and reduce greenhouse gas (GHG) emissions today, over the next decade, and beyond 2030, agricultural systems need to be transformed and agricultural productivity increased.

Transformation will not be easy. Several factors are creating serious challenges for global food security. In many high- and middle-income countries, diets continue to shift toward increased consumption of fats, oils, sugars, and meat products. Further, substantial increases in the use of food crops for industrial uses—biofuels and animal feed—are diverting resources from the food supply chain, and higher agricultural input costs, especially for fertilizers and fuel, are likely to significantly reduce food crop production among smallholder households. Climate change is also hurting agricultural production in many parts of the world. Thus, in many low-income countries, food insecurity and severe hunger persist for too many people and, in the wake of the Ukraine crisis, are on the rise.

Agriculture also substantially contributes to climate change; therefore, mitigating GHG emissions from the sector is key to climate mitigation.

Agriculture needs to use less land and water if the world is to reverse deforestation, halt the decline in biodiversity, and provide nonagricultural water supplies.

A transformation this large and rapid will require investments in creative innovations for sustainable agricultural intensification—innovations that seek to meet changing human needs while ensuring the long-term productive potential of natural resources, such as water and land resources and the associated ecosystems and their functions.

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Agricultural research is widely viewed as the most effective instrument in responding to the medium- and long-term challenges of sustaining and increasing food security while mitigating climate change. Public investments in agricultural research and development (R&D) continue to consistently generate high economic rates of return through agricultural productivity growth.[2]

The Role of the Consultative Group on International Agricultural Research

For low- and middle-income countries, the Consultative Group on International Agricultural Research (CGIAR) is a critically important institution that can address these food security and climate change issues. The CGIAR operates through research partnerships at 15 different international agricultural research centers. These include the two centers most closely associated with the green revolution of the 1960s and 1970s—the International Rice Research Institute and the International Maize and Wheat Improvement Center—and centers focusing on livestock, forestry, and other aspects of agricultural production.

The CGIAR has an annual research portfolio of just over $900 million with more than 9,000 staff working in 89 countries worldwide.[3] This funding is small relative to global agricultural R&D. The CGIAR accounted for only 4.2 percent of public agricultural R&D in developing countries in 2015, but investments in CGIAR research programs have been highly productive.[4] Julian Alston, Philip Pardey, and Xudong Rao, based on a comprehensive review of published studies on returns to investment, reported an average 10-to-one benefit-cost ratio on those investments.[5]

In response to perceived needs to restructure the CGIAR in the face of evolving challenges and donor demands, a new structure for managing the CGIAR has been established. "One CGIAR" has a common core of a CGIAR board and a system-level executive and support services structure intended to unify governance across the 15 different centers and their research programs, together with larger and less restrictive funding commitments.[6]

Newly developed CGIAR initiatives aim to create positive impacts in five key areas: climate adaptation and mitigation; environmental health and biodiversity; gender equality, youth, and social inclusion; nutrition, health, and food security; and poverty reduction, livelihood, and jobs. This is a broad agenda, so the CGIAR board and management need to prioritize key areas of research. Therefore, the key question is what priorities for CGIAR are the most relevant, given the food security and climate change challenges confronting agricultural sectors throughout the world.

Genetic Gains. The first priority should be what has always been the core reason for the CGIAR's existence: research on crop and livestock breeding for productivity growth, nutrition, and climate adaptation and mitigation. The bulk of funding for breeding should go to boosting yields and production efficiency, since increasing efficiency also contributes to reduced area expansion, deforestation, water use, and GHG emissions.

However, there should be a shift on the margin to climate-related crop breeding, nutrition content improvement, and non-staple crops. Traits to address climate change include drought and heat tolerance and resistance to pests and disease that will be more severe in hotter and wetter conditions.

Breeding of biofortified crops, such as orange-fleshed sweet potatoes, can reach malnourished rural populations that generally have limited access to diverse diets, supplements, and commercially fortified foods.

Finally, the CGIAR's long-standing focus on staple crops such as wheat, maize, and rice should be balanced with increased attention to foods such as vegetables, fruits, fish, pulses, nuts, eggs, dairy, and meat. These commodities are excellent sources of micronutrients, and plant-based commodities reduce the likelihood of diet-related chronic disease.[7]

Livestock programs should focus on not only production and productivity but also product quality, animal welfare, disease resistance, reductions in GHG emissions, and mitigation of other environmental impacts. Areas for R&D investments include optimizing livestock diets to reduce the environmental impacts of production, improving feed digestibility, enhancing water management and pasture quality, developing high-quality grain concentrates, improving waste management, use of by-products for energy production, and recycling. Integrated management of mixed crop-livestock systems could provide substantial water savings and livestock productivity.[8]

CGIAR crop breeding programs should be implemented in close partnership with national agricultural research systems (NARS), universities worldwide, farmer-led breeding initiatives, and the private sector when appropriate. A greater push should be made both within the CGIAR and through capacity building for NARS in low-income countries to increase research efficiency through the expanded use of genome-editing technology, genomics and bioinformatics, and high-throughput gene sequencing. NARS play an especially important role in partnerships with the CGIAR, identifying key targets for breeding programs, generating their own improved germplasm, adapting CGIAR-generated germplasm to local conditions, and facilitating links with farmers.

Resilient Farming Systems. The second major focus for CGIAR research should be developing scaled-up farming systems that boost farm-level efficiency, production, and income and thus become more environmentally friendly and climate smart. New farming systems can generate high returns, but improved farm technologies and systems are more complex and difficult to adopt than are seeds for improved crop varieties. In most cases, the benefits to farmers are not as visible, and it can take years to achieve net benefits relative to the costs of adoption. For example, implementing integrated soil and water management immediately increases costs, but yield gains can take years to realize as soil quality only improves over time.

Research on crop management and technologies should focus on improving the design of farming systems suited for local agroclimatic conditions that offer greater diversification of opportunities. There should also be a focus on improving the conditions that facilitate the adoption of those systems, including input and output markets, credit and finance, and targeted subsidies such as carbon payments and payments for environmental services.

Livestock systems and management research should focus on efficiency and productivity, practices that reduce methane emissions through improved feeding practices and feed additives, and improved manure management and water recycling. Innovative intensive grazing practices can lead to soil creation and soil health, enhancing soil moisture retention and fighting desertification.[9]

A key priority for farming systems' R&D investments should be developing advanced digital technologies—such as satellite imaging, remote sensing, and in-field sensors—which can support precision farming based on observations of, and responses to, intra-field variations that can guide the more efficient application of inputs and improve productivity and farm income. These technologies have mainly been focused on and profitable for large-scale farmers. Research is needed to support the adaptation of these advanced technologies to benefit small farmers.

Research is also needed on technologies and incentive policies that encourage small-scale farmers to adapt and adopt digital agriculture. These include speeding up cost reductions for sensors and related technologies and supporting local development partners and public-private partnerships in testing and refining technologies for context-specific applications. Innovation is especially important to integrate sensor technology and data applications into locally appropriate products and services that address problems affecting smallholder farmers.

Thus, funding should be increased for the CGIAR's Digital Innovation and Transformation Initiative, which targets improvements in farmers' and other decision makers' access to timely, reliable, and actionable information to inform production and marketing decisions. Collaboration and partnerships are essential here, including with NARS, farmer groups, nongovernmental organizations, and private-sector actors such as input and equipment dealers, to best scale up farming systems' innovations.

Value Chains. A third priority area for the CGIAR is research and partnerships that better integrate small-scale farmers into modernized input and farm-to-market value chains. Effective and accessible value chains are essential in low- and middle-income countries (LMICs) to give small-scale farms entrées to markets and access to inputs and technology at reasonable prices.

Revolutionary changes in processing, wholesale, and retail segments of the value chain are taking place. The transformation includes consolidation of value-chain operations, rapid institutional and organizational change, and modernization of input and agricultural crop and livestock procurement systems. These changes include the rapid rise of supermarkets, large and modern food processors, and wholesale firms.[10] But many LMIC farmers are missing out on the revolution and still face barriers in using the value chain, including high transport, communication, and transaction costs.

These high costs are the result of inadequate infrastructure, lack of information, insufficient credit, and policy distortions, all of which limit or prevent small-scale farms from connecting to market systems. As with farming systems, information and communications technologies could improve value-chain performance. Sensors linked to digital information systems can improve links between farmers and processors, reduce postharvest losses with digitally enabled harvest loans and warehouse receipts, monitor storage conditions and track provenance to allow grading and inform consumers, reduce costs of transport, increase choice of markets and transport for farmers, and increase access to timely information.

Thus, the CGIAR should implement a major effort that integrates research on effective policies, technologies, and institutional arrangements to improve small-farmer access to advanced markets. Institutional partnerships, including public-private partnerships and contract farming, are also essential, as is developing farmer cooperatives and farm clusters that can balance the market power many traders enjoy.

Policy and Governance. The fourth priority is assessing the impacts of policy and governance on sustainable food security and designing appropriate policies. The first area of focus should be natural resource, climate, and related sectoral policy. Policies frequently undermine the effectiveness of technology and farming systems. Price supports for rice, wheat, and maize make these crops more profitable, discouraging the efficient allocation of land between staple crops and diversified nutrient-rich crops. Fertilizer, water, energy, and pesticide subsidies induce overuse of cheap fertilizer, water, and other inputs, resulting in excess GHG emissions and environmental degradation.

Applied policy research, integrated with farming systems research, is needed to facilitate the effective adoption of such new technologies with balanced incentives that do not disadvantage small farmers.

Many current policy programs have therefore inhibited the adoption of climate-smart and resource-saving technologies by small-scale and other farms. Such technologies include the use of crop rotations and cover crops, conservation tillage and residue management, improved water management through precision agriculture and water harvesting, improved pasture management use of legumes, and improved manure management systems in livestock systems. Applied policy research, integrated with farming systems research, is needed to facilitate the effective adoption of such new technologies with balanced incentives that do not disadvantage small farmers.

A second policy focus should be the impacts of international and high-income country (HIC) policies on LMICs. In this interconnected world, actions taken anywhere in the world can affect food security in LMICs. International trade policy is the most obvious example that directly affects LMICs by influencing the prices facing farmers and consumers and access to import and export markets.

Less obviously, many other policies in HICs can substantially affect LMICs. For example, climate change mitigation and environmental policies in European and North American countries can unintentionally increase vulnerabilities in river basins throughout the developing world as production shifts to LMICs that do not have strict climate change policies.[11] The CGIAR can play an important role in identifying pressure points and responses through its foresight work.

Conclusion

These are daunting priorities for the CGIAR. Additional—and more flexible—support from donor countries and organizations is needed. Most funding in recent years has had a short-term focus and has been tied to the demonstration of almost immediate impacts. This type of funding has reduced the CGIAR's and its researchers' effectiveness. As David Lobell notes, donors have required "more oversight, more prescription, more reporting, more short-term projects, and more strategic reviews," which has reduced the time for and investments in impactful science.[12] A major success for One CGIAR would be to provide its scientists the funding and time to achieve advances in the priority areas discussed in this report.[13]

About the Author

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Notes

1. UN Department of Economic and Social Affairs, "Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture," 2022, https://sdgs.un.org/goals/goal2.
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3. Consultative Group on International Agricultural Research, "Funders," https://www.cgiar.org/funders/.
4. Julian M. Alston, Philip G. Pardey, and Xudong Rao, "The Payoff to Investing in CGIAR Research," Supporters of Agricultural Research Foundation, October 2020, https://supportagresearch.org/assets/pdf/Payoff_to_Investing_in_CGIAR_Research_final_October_2020.pdf.
5. Alston, Pardey, and Rao, "The Payoff to Investing in CGIAR Research."
6. Christopher B. Barrett, "On Research Strategy for the New One CGIAR: Editor's Introduction," *Food Policy* 91 (February 2020), https://www.sciencedirect.com/science/article/abs/pii/S0306919220300282.
7. Lawrence Haddad, "Viewpoint: A View on the Key Research Issues That the CGIAR Should Lead on 2020–2030," *Food Policy* 91 (2020), https://www.sciencedirect.com/science/article/abs/pii/S0306919220300087.
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9. Thornton, "Livestock Production."
10. Thomas Reardon and C. Peter Timmer, "The Economics of the Food System Revolution," *Annual Review of Resource Economics* 4 (August 2012): 225–64, https://doi.org/10/1146/annurev.resource.050708.144147.
11. Matteo Giuliani et al., "Unintended Consequences of Climate Change Mitigation for African River Basins," *Nature Climate Change* 12 (January 2022): 187–92, https://doi.org/10.1038/s41558-021-01262-9.

12. David B. Lobell, "Viewpoint: Principles and Priorities for One CGIAR," *Food Policy* 91 (February 2020), https://www.sciencedirect.com/science/article/abs/pii/S0306919220300099.

13. For lengthier discussions of Consultative Group on International Agricultural Research priorities and other viewpoints, see ScienceDirect, "On Research Strategy for the New 'One CGIAR,'" February 20, 2020, https://www.sciencedirect.com/journal/food-policy/special-issue/10ZH9P5WC1R.