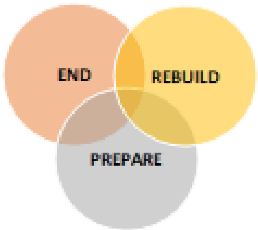
Investing in Climate Change Adaptation and Agricultural Innovation Is Essential for Our Future



The Bill and Melinda Gates Foundation is currently focusing on three core cross-cutting priorities: containing the global COVID-19 pandemic, rebuilding through an accelerated economic recovery, and better preparing the global system for future pandemics. In our previous white paper on economic recovery, we highlighted the criticality of agriculture given its importance to economic growth and job creation in low- and middle-income countries and the urgency of future-proofing the sector against climate change. Over 50% of Africa's workforce is in agriculture, so any disruption to the sector affects not only food security but also economic, social, and political stability.

In this paper, released in the lead-up to the 26th UN Climate Change Conference of the Parties (COP26) in November 2021, we highlight the growing negative impacts of climate change on lives and livelihoods, and we call for urgent action to increase investment in climate adaptation, particularly climate-smart agriculture.

Executive Summary

The world is getting warmer, particularly in sub-Saharan Africa.

The climate change crisis is underway, with significant and growing negative impacts, particularly on rural livelihoods. Many millions are already suffering the devastating effects of a warming planet. Efforts to tackle climate change must aim to both reduce the future impact of the climate crisis, by reducing greenhouse gas emissions, and adapt to the already changing climate.

The world is already about 1 °C warmer than pre-industrial levels, and we're on track to live in a world that is 1.5 °C warmer as soon as the 2030s.[1] Business as usual places the world on a pathway to a 3-5 °C increase by the end of 2100. Even if all current climate change commitments were fully delivered upon, there would still be a 2-3 °C increase. As frightening as they are, these global averages obscure severe regional variations. By 2050, areas that currently provide 70% of the total value of crop production in sub-Saharan Africa will come from areas with aridity and heat stress at "severe" or "extreme" levels.[2] These levels signal an inability to complete agricultural work or significant health risk in doing so. This means most agricultural production in sub-Saharan Africa will need to adapt to increasing temperatures and aridity.

Unfortunately, the countries that will be hit hardest and fastest by projected temperature rises and other impacts of climate change are also the ones that lack the financial resources to build resilience ahead of time and that contributed the fewest emissions toward the current crisis. The economies of these countries are highly dependent on agriculture, which accounts for more than half of employment in sub-Saharan Africa[3] and up to 30% of GDP. The agricultural sector is at severe risk of being affected by heat, drought, floods, storms, and sea level rise, potentially devastating the lives and livelihoods of hundreds of millions of people. We can already start to see the impacts unfolding across the world, and we need rapid scaling up of proven adaptation solutions alongside major new investment in innovation to tackle the risks on the horizon.

The COVID-19 pandemic and the rapid development of the COVID-19 vaccine have shown us that diverse global actors can come together in extraordinary ways to advance scientific discovery in a crisis. Yet the pandemic has also exposed the fragility of the systems that support our way of life and underscored the need to build greater resilience to exogenous shocks. We need to act immediately and decisively on climate and align short-term growth with long-term resilience. We must catalyze the innovations necessary to cope with 1.5 or 2 °C temperature rises and equip ourselves ahead of time to act should temperatures rise even further. The alternative is a destructive cycle of more frequent and extreme climate shocks, followed-by ever more costly reconstruction. It takes time for new innovations to progress from laboratories to farmlands. Ensuring that we are ready to adapt to climate change requires political foresight and leadership, large-scale frontloaded investments, and coordinated global and national efforts.

There are clear actions that global leaders can take to help.

Climate-smart agriculture approaches aim to sustainably increase agricultural productivity and incomes and ensure that food systems are resilient to climate change, while at the same time reducing the environmental footprint of the agriculture sector. Ahead of this year's COP, the Gates Foundation calls for two urgent areas of action from governments and other funders:

- Rapidly scale up funding for climate adaptation, including scaling up of existing solutions.

    - **Make additional grant financing available for climate adaptation.** The Paris Agreement on climate change reaffirmed the commitment of developed countries to jointly provide $100 billion annually by 2020 for climate action while significantly increasing adaptation financing from current levels. Climate financing mobilised by developed countries increased to $78.9 billion in 2018 according to the OECD, but is still estimated to have fallen short of the $100 billion target in 2020.[4] Currently only around 21% of developed countries' bilateral and multilateral public funding to low- and middle-income countries (LMICs) funds climate adaptation activities. [5] It is estimated at least 74% of public climate financing is in the form of loans rather than grants.[6]

    - **Prioritize investment and financing to future-proof the key economic drivers of sustainable and inclusive growth in low-income countries**, including investment to build the resilience of farmers' livelihoods and help the agricultural sector withstand climate effects.

    - **Shape and fund the proposed Resilience and Sustainability Trust** of the International Monetary Fund (IMF), a vehicle for channelling Special Drawing Rights (SDRs), to help address the macroeconomic challenges facing LMICs, including the physical and transition risks posed by climate change.

- **Increase investment in innovation and R&D for agricultural adaptation.**
  - **Join the** Agriculture Innovation Mission for Climate (AIM for Climate), a new initiative seeking to increase and accelerate investment in climate-smart agriculture and food systems innovation, and accelerate coordinated action on the most pressing research priorities over the coming five years (2021–2025).
  - **Fully fund** CGIAR , the largest global research partnership for sustainable and resilient agriculture, so that it can carry out critical adaptation research and development to ensure that food systems are resilient and productive despite climate change, innovate to boost productivity and incomes for farmers, and nourish a rising global population as climate change worsens growing conditions.

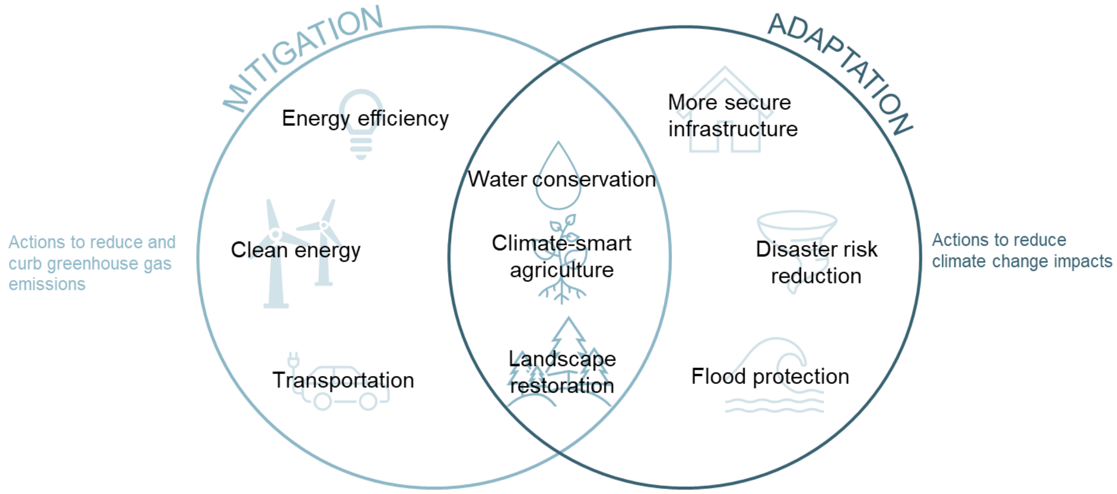
Investing in Adaptation: Essential for Our Future

This paper outlines the case for investing in adaptation to existing climate change alongside efforts to mitigate future climate change and why investing in climate-smart agriculture should be a priority for climate funding. The paper then briefly summarizes the current state of international climate financing, highlighting the shortfalls in financing for adaptation, and provide examples of vehicles for donors to increase funding for agricultural R&D and innovation in the face of climate change.

Climate Change: Not Just a Future Crisis

Climate change brings harsh effects, especially on rural communities. It brings about changes in the natural environment that directly affect everyone's way of life—our food systems, our health,[7] and our economies. Mitigating future climate change by reducing greenhouse gas emissions and other actions is vitally important. But many millions are already suffering the devastating effects of a warming planet. This is why any efforts to tackle climate change must both deal with the future crisis *and* adapt to the present challenges.

Figure 1: Examples of climate mitigation and adaptation interventions



To effectively adapt to climate change, the global community must adopt four methods of engagement:

- Enhance and diversify ongoing adaptation efforts to address the negative impacts of climate change *already* being experienced.
- Build adaptive capacity and reduce sensitivity to the *near-term* negative impacts of climate change that are already locked in.
- Ensure that systems can rapidly and effectively respond to the most disruptive impacts of climate change over the *medium term*.
- Ready mechanisms to build back after unforeseen and unexpected compound shocks in the *longer term*.

There is an urgent need for more concerted action and financing to accelerate innovation in adaptation because, in many current agricultural systems, the operating environment for agriculture will soon shift beyond what can be managed through incremental adjustments. Climate change is shifting what's possible and optimal in terms of crop and animal suitability in many agricultural landscapes, which suggests the need to deploy deeper innovations, more fundamental shifts in the sector, or both in many cases.

By scaling existing solutions and focusing on the development and deployment of new technologies and adaptation strategies, we can create a paradigm shift in our ability to meet the current and future challenges posed by a changing climate.

Poverty and vulnerability are often experienced by the same people, who will suffer disproportionately as these impacts become more extreme—and these are also the people who have contributed the least to the causes of climate change. For example, sub-Saharan Africa has the lowest average per capita emissions of carbon dioxide globally, but under current trajectories nearly all African countries are on track to experience a 2-degrees increase in temperatures between 2025 and 2040.[8] The Intergovernmental Panel on Climate Change (IPCC) believes this level of temperature increase will be a tipping point, leading to devastating impacts on crop and livestock farming and human health, with very high risk of undernutrition in communities dependent upon dryland agriculture.

We can already track the growing impacts of climate change. The world is experiencing more drought, heat, storms, flooding, and sea level rise. Models predict that the impact will be even more extreme in the near future, with each shock able to wipe out decades of progress in development.[9] For example, projections show that climate change will slow progress toward eliminating hunger, with an additional 78 million people facing chronic hunger in 2050 relative to a no-climate-change future; over half of these people are in sub-Saharan Africa.[10]

Growing transparency on the physical risks of climate change may well encourage investors to move their capital to countries and sectors where their investments appear more secure. The cost of capital for those on the front lines of climate change will surely increase—as it has done already in response to the more limited impacts to date. Climate vulnerability's impact on the average increase in cost of debt from 1991 to 2017 has been 0.63%; the indirect effect through climate vulnerability's impact on financial leverage has contributed an additional 0.05%.[11]

Supporting countries to build resilience to the future impacts of climate change is critical for preventing a divergence of growth trajectories as part of the economic recovery. Current estimates of the cost of climate change range between US$7 billion and $15 billion per year to Africa alone. This is expected to rise, with climate-induced losses reaching as much as 15% of GDP per capita growth in some scenarios.[12] In order to help address medium-term macroeconomic threats, including those posed by climate change, to components of demand and supply as well as potential productive capacity and economic growth, the IMF has proposed developing a Resilience and Sustainability Trust as a vehicle for channelling SDRs. Discussions for this project are currently at a very early stage. We hope this can become a vehicle to help LMICs address the physical and transition risks posed by climate change which, if left unaddressed, would have devastating economy-wide impacts including for agriculture and wider food systems.

African governments have placed sustainable and resilient agriculture at the top of their national priorities in nationally determined contributions (Paris Agreement NDCs) as well as committing to increase their own investment into agricultural R&D.[13] Continental priorities, confirmed through the African Union's Green Recovery Action Plan and the work of the United Nations (UN) Economic Commission for Africa reaffirm this point.

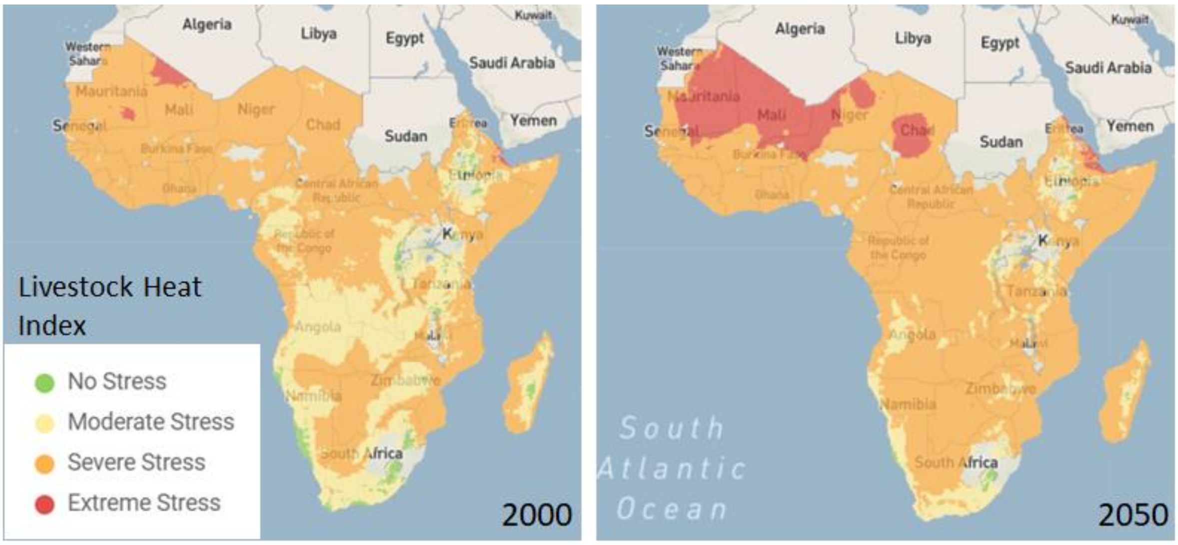
The pace of climate change is undermining existing adaptation solutions, and the level of investment in innovation for adaptation today is well below what is needed to scale up the use of existing tools develop and deploy new tools at speed. Mark Carney (former central banker and now the UN envoy for climate action and finance) has argued that the world is heading for mortality rates equivalent to the COVID-19 crisis every year by 2050, absent urgent action on climate change.[14] By 2100, climate change could be five times deadlier than COVID-19.[15]

Agriculture: An Essential Focus for Climate Adaptation

Changes in patterns of rainfall and increasing temperatures are already having a severe impact on agricultural systems, [16] leading to reduced crop yields and livestock output or even crop failure, with these negative impacts set to accelerate as determined by the Intergovernmental Panel on Climate Change using the representative concentration pathway RCP 8.5 (see Figure 2).[17] Although agricultural total factor productivity doubled from 1961 to 2015, a recent study found that growth would have been 20% greater globally if not for the accumulated impacts of climate change, a loss equivalent to the last seven years of productivity gains.[18] This productivity drag averaged 34% for sub-Saharan African countries, equivalent to well over a decade of realized gains. On average in sub-Saharan Africa, yield losses for maize, wheat, and rice are expected to grow super-linearly with rising temperatures and increasing drought severity.[19] Currently an estimated 90% of agricultural production in sub-Saharan Africa is rainfed which means seasonal excess water and drought play a key role in determining crop productivity.[20]

These losses—past, present, and future—have important implications for the conservation of nature and the protection of biodiversity and valuable ecosystems. In the absence of sustainable intensification and comprehensive land-use planning, farmers have independently sought to increase the area of land they cultivate, in order to maintain their livelihoods and remain above the poverty line. Bringing new land into cultivation, often at the cost of valuable forests or mangroves, also has the impact of releasing additional greenhouse gases, which are often not factored into current climate modeling.

Figure 2: Livestock Heat Index stress level shown in 2000 and projected for 2050 using RCP 8.5. (Moderate to extreme stress levels cause significant discomfort to cattle, reduce their productivity, and sometimes even cause cattle death.)

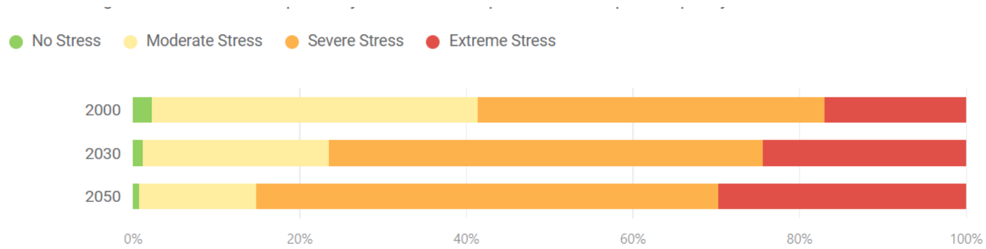


The provision of high-density animal protein is essential for nutrition in many parts of the world, especially for poorer people and children, and the demand will be exacerbated by population growth. However, the effects of climate change are likely to impede the ability of livestock producers to supply eggs, milk, and meat. A recent study has indicated that much of East Africa will become almost unsuitable for swine, poultry, and dairy cattle production due to heat stress.[21,22] Enhancing animal health and productivity can help to maintain smaller herd sizes and reduce overall greenhouse gas emissions.

Internal Gates Foundation modelling shows that by 2030, almost 200 million people in Africa will live in areas where the temperature has increased more than 2 °C, with 57 million hectares of crops and 60 million livestock affected, totaling US$23 billion in production value.[23] Without accounting for future population growth and migration, by 2050, there will be over 1 billion people in Africa living in such areas, with 229 million hectares of crops and 245 million livestock affected, totaling $138 billion in production value (see Figure 3).[24]

By 2050, 70% of the total crop value of production in sub-Saharan Africa will come from areas rated at “severe” or “extreme” aridity stress levels (implying an inability to complete agricultural work or significant health risk in doing so).[25] Under such circumstances, it is not unthinkable that food systems could come close to collapse, and entire communities may need to relocate in search of new livelihoods.

Figure 3: The percent of land area in sub-Saharan Africa under each heat stress classification over time (projected values based on RCP 8.5 scenario).



The impact of climate change on agriculture will have multiple knock-on effects for individuals, communities, and the economy. Climate-induced productivity and price impacts for nutrient-rich foods will contribute to further declines in affordability of and access to nutritious diets, increasing the threat of hunger, malnutrition, and food insecurity. Over 50% of Africa's workforce is in agriculture, so disruption to agriculture affects not only food security but also economic security and stability. Women, in particular, comprise a significant proportion of those working in agriculture and yet experience much lower levels of agricultural productivity as a result of lower access to critical assets like land, labor, education, and information. These underlying inequalities may amplify the threats that climate change poses to women and girls**.** In addition, the World Bank estimates that 143 million people could be forced to migrate internally by 2050 due to climate hazards.[26] Food insecurity and economic losses caused by climate-induced effects on agriculture could increase the impetus for internal migration and deforestation still further, as farmers are displaced in search of more productive land or in search of new jobs outside the agriculture sector.

Fortunately, these unwelcome climate change outcomes are not inevitable—if appropriate, urgent action is taken. The Global Commission on Adaptation pointed to proven adaptation solutions and investment opportunities that could considerably reduce the impact of expected climate impacts.[27]

To help farmers prosper despite climate change, governments will need to invest in agricultural adaptation. Shifting suitability thresholds, land potential, water availability, and the emergence of new pests and diseases caused by climate change all require research and development of new products and processes. Climate-smart agriculture approaches have the proven potential to sustainably increase agricultural productivity and incomes and boost food systems resilience, while at the same time reducing the environmental footprint of the agriculture sector.

Effective innovations can include seeds and livestock bred to be more resistant to climate stresses such as heat, drought, flooding, humidity, pests, and diseases. Many other innovative solutions can manage risk, such as financial tools, policy tools, digital tools, and social networks. Technologies that help governments monitor changes in soil, water, weather patterns, food markets, and farm productivity (such as digital soil mapping) and climate-sensitive diseases of livestock allow for better policymaking. Innovation in agriculture must build on indigenous knowledge and take account of the diverse cultural contexts for agricultural and food systems. Working closely with national and local actors on the front lines of adaptation is integral to the success and sustainability of new innovations. Fundamentally adaptation is a local activity; however, greater ambition and accelerated action can be unlocked by research and innovation.

Such innovation approaches can help ensure that farms remain productive despite the known and threatened impacts of climate change. This in turn helps secure the availability of high-quality nutritious food, brings economic stability, and can help prevent the disruption of lives and livelihoods that depend on agriculture.

There is a clear window of opportunity for effective global efforts on agriculture adaptation. However, governments need to move fast, investing now in the future solutions that will help protect against the worst effects of an already warming planet.

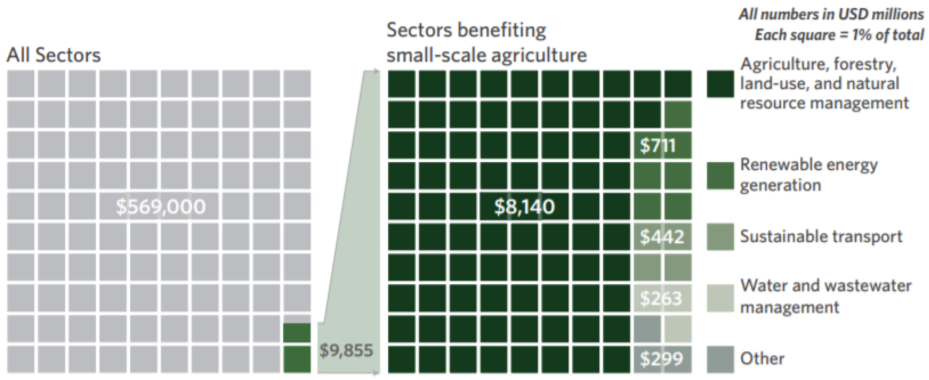
Climate Adaptation Requires Urgent Increased Investment

As part of the 2015 Paris Agreement, world leaders committed to "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development."[28] The Paris Agreement reaffirmed the commitment of developed countries to jointly provide $100 billion annually to developing countries by 2020 for mitigation and adaptation while significantly increasing adaptation financing.[29] High-income countries have missed this target. In 2018, climate finance provided and mobilised by high income countries for LMICs was estimated at $78.9billion.[30] Currently only around 21% of high-income countries' bilateral and multilateral public finance to LMICs flows to adaptation, with at least 74% of total public climate financing in the form of loans rather than grants. [31]

The UN Environment Programme estimates that annual adaptation costs in LMICs are expected to increase from $70 billion in 2020 to between $140 billion and $330 billion in 2030, before rising to the range of $280 billion to $500 billion by 2050.[32]

Financing on climate adaptation falls far short of these needs[33] and is dwarfed by spending on climate mitigation. According to Climate Policy Initiative (CPI), total climate finance flows—including domestic and international, public and private—were estimated at $579 billion per year for 2017–2018. Of these funds, $537 billion of tracked finance went to mitigation, with $30 billion to adaptation.[34] The vast majority of this funding came from public actors and was invested domestically. The International Fund for Agricultural Development and CPI estimate that in the same period, only around 1.7% ($10 billion) of total climate financing flowed to small-scale agricultural producers in developing countries (see Figure 4).[35] This is a disproportionately low amount, considering both the toll of climate change on lives and livelihoods of the approximately 570 million smallholder farmers globally and the macro-economic impact of climate disruption to a sector that represents a significant portion of GDP in South Asia and sub-Saharan Africa. This is, in effect, less than $20 per household, and often these funds do not reach the farmers that need them.[36]

Figure 4: Share of annual climate financing in small-scale agriculture relative to other climate financing, 2017–18 (rounded in US$ million)



Source: *CPI analysis based on Global Landscape of Climate Finance 2019*

The Supporters of Agricultural Research (SoAR) Foundation calls for at least a doubling of the total public investment in the agricultural R&D that is performed by both national and international agencies. This would allow these agencies to meet expanding demand for new technologies to tackle the ongoing challenges to global good supplies and farmer livelihoods posed by weather, pests, political strife, and policy and market risk.[37] The International Food Policy Research Institute estimates that annual investment in international agricultural research needs to increase from $1.62 billion to $2.77 billion per year between 2015 and 2050. Additional water and infrastructure investments are estimated to be more expensive than agricultural R&D, at about $12.7 billion and $10.8 billion per year respectively, but these funds would address key gaps to support transformation toward food system resiliency.[38]

Investing in agricultural innovation is not only key to helping reduce poverty and hunger and improving economic stability for the world's poorest. It also benefits high-income countries. Technology developed by CGIAR has helped to triple yields in Europe and North America, as well as having a profound impact on economic development and poverty reduction in the developing world.[39] Improved plant varieties continue to improve yields and increase climate resilience for food producers globally, in turn contributing to global food price stability, benefiting global consumers.

Addressing the Funding Shortfall

To address the shortfall of funding necessary to support innovation in agricultural climate adaptation, urgent investment is needed. The Agriculture Innovation Mission for Climate and CGIAR are effective vehicles for coordinated, strategic global action and investment.

The [Agriculture Innovation Mission for Climate (AIM4C)] is a voluntary initiative that brings participants together to increase investment in climate-smart agriculture and food systems innovation over the five years spanning 2021 to 2025 while accelerating its pace. It seeks to catalyze coordinated action between as well as within governments across all relevant ministries that invest in agricultural research, development, and deployment. The initiative has a growing coalition of support from government, philanthropic, and institutional partners including the Gates Foundation.[40] Those who join the initiative demonstrate a commitment to significantly increase investment in agricultural innovation to address the climate crisis. Members are provided with political and technical structures and frameworks to enhance cooperation and coordination on shared research priorities in high-potential areas or against significant unmet needs.

CGIAR is the largest global research partnership for agriculture. Each of its centers works to address global challenges concerning food security. Drawing on its global crop genetic resources and expert plant breeding programs, CGIAR works with farmers to ensure they benefit from productive, resilient crops that also meet the needs of consumers. CGIAR is home to the International Livestock Research Institute, the leading global institution on livestock research spanning animal health, production, livestock economics and policies, gender, and nutrition. Continued funding for the core body of CGIAR work is essential to guarantee that it can continue critical research and innovation in agriculture and make those innovations accessible to all (see sidebar for examples). Yet CGIAR currently receives less than $1 billion per year (equivalent to $2 per smallholder farmer), well below the estimated $2 billion per year that it requires to deliver against these challenges, including through its 2030 Research and Innovation Strategy.[41] Its work to ensure that food systems are capable of simultaneously delivering greater volumes of nutritious food, whilst reducing food waste and lowering agriculture's environmental footprint is vital to the achievement of the Sustainable Development Goals and to support the Paris Agreement.

CGIAR: Examples of Impact

- The CGIAR System currently supports breeding programs on some 20 crop and forage species, targeted to specific agro-ecologies throughout Asia, Central and South America, sub-Saharan Africa, West Asia, and North Africa. Last year, 417 improved varieties were made available for use.
- In Zimbabwe, farmers in drought-stricken areas using drought-tolerant maize are able to harvest up to 600 kilograms more maize per hectare than farmers using older varieties—meaning an extra $240 in income or helping to feed a family of six for nine months. Gains in productivity are critical for avoiding additional land conversion to cultivation and associated greenhouse gas emissions.
- Climate-smart solutions have increased resilience, income, and yield for 4.75 million farmers in India working across 3.7 million hectares by scaling CGIAR-developed natural resource management practices.
- In Latin America, thanks to support from the CGIAR, 500,000 farmers are receiving tailored agroclimatic information; improving their decision-making; and advancing resilient landscapes, livelihoods, and food security.

Conclusion

The COVID-19 pandemic has demonstrated that we need to act swiftly while planning ahead and building more global and national resilience to exogenous shocks. However, it takes time for new innovations to progress from upstream research to deployment in the real world. Ensuring that we are ready to adapt to climate change requires political foresight, long term investment, and coordinated global efforts. Ahead of COP26, we are calling on countries to **rapidly scale up funding for climate adaptation**, and urgently **increase investment in innovation and R&D for**

agricultural adaptation, including by joining the **Agriculture Innovation Mission for Climate (AIM for Climate)** and significantly increasing overall investment in the **CGIAR.**

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[2] Internal BMGF modeling calculated using RCP 8.5 for projections. Heat stress taken as the number of days with mean daily temperatures above a given threshold during the flowering period. We define a heat stress day when Tmax ≥ 40ºC. Thresholds: No significant stress: 0 days; Moderate: 1 – 5 days; Severe: 5 – 10 days; Extreme: > 10 days. Aridity measured using Thornthwaite's Aridity Index which measures the amount of rainfall in an area versus the potential evapotranspiration demand, and using this as a proxy for agricultural drought. Areas of severe and extreme stress have very little rainfall compared to cropland evaporation and transpiration needs. Heat stress measured by number of days per month

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[22] Internal BMGF modeling calculated using RCP 8.5 for projections see footnote 2

[23] Internal BMGF modeling calculated using RCP 8.5 for projections see footnote 2

[24] Internal BMGF modeling calculated using RCP 8.5 for projections see footnote 2

[25] Internal BMGF modeling calculated using RCP 8.5 for projections. These classifications correspond to temperatures over 32 °C, implying an inability to complete agricultural work or significant health risk in doing so.

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[41] Over the last 7 years, CGIAR annual revenue has varied from a high of $1.08b (2014) to a low of $736m (2020). See CGIAR Financial Dashboard, Accessed October 14, 2021. https://www.cgiar.org/food-security-impact/finance-reports/dashboard/overview/ . CGIAR seeks to increase funding to $2b/year CGIAR *Investment into Research Must Double to Halt Climate and Food Crises by 2030,* Jan 2021, Accessed October 14, 2021 https://www.cgiar.org/news-events/news/investment-into-research-must-double-to-halt-climate-and-food-crises-by-2030/