RESPONDING TO COVID-19:
CGIAR'S CONTRIBUTION TO GLOBAL RESPONSE, RECOVERY AND RESILIENCE

CONTENTS

ABBREVIATIONS

A4NH	CGIAR Research Program on Agriculture for Nutrition and Health
AGRA	Alliance for a Green Revolution in Africa
AIDS	Acquired immunodeficiency syndrome
AMR	Antimicrobial resistance
BecA	Biosciences eastern and central Africa
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CRP	CGIAR Research Program
GDP	Gross domestic product
GLDC	CGIAR Research Program on Grain Legumes and Dryland Cereals
FAO	Food and Agriculture Organization of the United Nations
FISH	CGIAR Research Program on Fish
FTA	CGIAR Research Program on Forests, Trees and Agroforestry
ICIPE	International Centre of Insect Physiology and Ecology
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
LIVESTOCK	CGIAR Research Program on Livestock
LMICs	Low- and middle-income countries
LSHTM	London School of Hygiene & Tropical Medicine
MAIZE	CGIAR Research Program on Maize
MERS	Middle East respiratory syndrome
NARES	National agricultural research and extension system
NGO	Non-governmental organization
OIE	World Organisation for Animal Health
PIM	CGIAR Research Program on Policies, Institutions and Markets
RICE	CGIAR Research Program on Rice
RTB	CGIAR Research Program on Roots, Tubers and Bananas
SARS	Severe acute respiratory syndrome
SMEs	Small- and medium-sized enterprises
UN	United Nations
USAID	United States Agency for International Development
WAHO	West African Health Organization
WASH	Water, sanitation and hygiene
WFP	World Food Programme
WHEAT	CGIAR Research Program on Wheat
WHO	World Health Organization
WLE	CGIAR Research Program on Water, Land and Ecosystems

EXECUTIVE SUMMARY

Food systems under threat

The COVID-19 pandemic, itself likely the result of unsustainable food, land and water systems, is exposing weaknesses in food systems, societies and economies around the world.

The health risks of the pandemic, combined with the social and economic impacts of measures to stop the spread of the disease (e.g. social isolation directives, travel bans, border closures) are posing threats to food, nutrition and water security, as well as continued progress on global goals to end poverty and hunger, especially in low- and middle-income countries. Without substantial emergency relief, 140 million people could fall into extreme poverty, potentially increasing hunger and malnutrition for millions. Women, youth, migrant workers and poor urban populations are among those most significantly impacted.

The global response to the pandemic must be swift and science-based, harnessing new and existing knowledge. Solutions need to be coordinated across sectors to provide immediate **response** and assistance for those most in need, ongoing and inclusive support in **recovery** and, perhaps most importantly, future **resilience** to all shocks–including climate extremes.

The COVID-19 crisis presents an unprecedented opportunity for humanity to **"build back better,"** particularly in the food systems at the root of the pandemic. The crisis has demonstrated how quickly society can fail – but also that collective positive change in human behavior is possible at scale and speed. CGIAR will join its network of partners to co-lead global debate and action on what "building back better" looks like for food, water and land systems.

A moment of opportunity for One CGIAR to make a difference

The crisis occurs as CGIAR undergoes pivotal change. An **integrated leadership and Board** in place this year can support the level of collaboration required for an integrated global and in-country response. The new **CGIAR Research Strategy 2022–2030** will be a tool to address the new context that this crisis generates, an opportunity to show the flexibility and depth of CGIAR expertise to address challenges that demand multidisciplinary solutions.

CGIAR's rapid response to COVID-19

CGIAR, in coordination with global, national and local partners, has responded by actively sharing its existing and emerging knowledge and experience to address the challenges posed by COVID-19. At the **country level**, CGIAR is supporting governments' responses to COVID-19. In Bangladesh, for example, CGIAR is working with local partners to monitor food, labor, input, supplies and prices and to advise on appropriate policies, with an emphasis on mitigating COVID-19 impacts on the most vulnerable members of society.

At the **global level**, CGIAR is working together with United Nations (UN) agencies and other development partners. For example, a collaboration with International Fund for Agricultural Development (IFAD) is exploring phone survey-based assessments for understanding the impacts of COVID-19 on rural households' livelihoods and food security, while work with World Health Organization (WHO) on sleeping sickness, a deadly endemic disease with a zoonotic interface, is transferring lessons useful for the current pandemic.

Stepping up CGIAR's global contribution

Around two-thirds of the current CGIAR Research Portfolio has immediate relevance to the COVID-19 response and all CGIAR research is relevant to global efforts to "build back better". The work of most immediate relevance encompasses **four research pillars:** (i) Food systems; (ii) One

Health (the human-animal-environment health interface); (iii) Inclusive public programs for food security and nutrition and (iv) Policies and investments for crisis response, economic recovery and improved future resilience.

By immediately **pivoting the current CGIAR program of work**, CGIAR can leverage its tools and evidence to help countries cope with the effects of the pandemic. For example, CGIAR is deploying economic models to assess the impacts of COVID-19 on poverty and food security, livestock data analytics to support efforts to develop a COVID-19 vaccine, assessments of the risks and benefits of wet markets and monitoring of the effectiveness of nutrition programs during the pandemic.

CGIAR aims to establish a **"CGIAR COVID-19 Hub"** across CGIAR and key partners for the coordination of major streams of relevant research, engagement and communications. The CGIAR COVID-19 Hub will be run in partnership with the London School of Hygiene & Tropical Medicine (LSHTM).

Short-term response, medium-term recovery and long-term resilience. In the **short term (up to 12 months)**, CGIAR research will deliver research across the four pillars to support crisis **response** by providing evidence and tools for immediate decision-making and actions in support of food availability and access, One Health interventions and public programs, policies and investments at scale. High-frequency, on-the-ground monitoring data and scientific evidence will help policymakers and implementers assess the underlying preparedness and resilience of societies to provide adequate and diverse food for, and to protect, different segments of their communities.

For the **medium term (up to 18 months)**, innovations will target crisis **recovery** by contributing to a better understanding of the impacts and trade-offs of the crisis response. Research evidence is critical to determining and prioritizing effective, gender-sensitive and socially inclusive action to ensure food and nutrition security. Country "deep dives" with COVID-19 impact modeling and analyses will assist governments with reassessing policy priorities under COVID-19. One Health risk-based approaches to agriculture and environmental management and emerging zoonoses, as well as antimicrobial resistance (AMR) will be essential.

For the **long term (up to 24 months and beyond)**, CGIAR will widen its focus to build greater **resilience** into food, land and water systems. CGIAR science will generate evidence and tools to prevent and respond both to emerging disease threats and to comparable food system shocks. The aim to **"build back better"** and not return to business as usual following the COVID-19 crisis is a priority for a united CGIAR in its efforts to transform food systems to meet global goals on food security, sustainable development and climate change.

1. Introduction

The COVID-19 pandemic that is causing massive disruptions to health, economies and livelihoods worldwide is itself a likely result of unsustainable food systems. This global health crisis and the consequent economic downturns are elevating the risk of new and different types of food crises attended by growing poverty and malnutrition, in low- to middle-income countries (LMICs). As the world's largest agricultural research network, CGIAR—with 15 advanced research centers working in and for developing countries, 16 multi-institutional research programs and platforms working in more than 75 countries and a critical mass of 800 scientists and hundreds of partners around the world—is uniquely positioned to provide evidence to policymakers, innovations to partners and tools to food system actors. CGIAR knowledge and experience will be harnessed over the short, medium and long terms to address the specific challenges COVID-19 presents in developing countries. CGIAR will rapidly inform policy and programmatic responses with the best available research-based data, models and evidence and will do so by consistently applying a people-centered focus on gender, nutrition and livelihoods.

Driven by CGIAR's mission, "Ending hunger by 2030 through science to transform food, land and water systems in a climate crisis," this proposed research agenda will provide timely, measured, useful and synthesized agricultural-research-for-development information and action on critically important COVID-19 issues. All outputs will aim to be universally credible, solutions-oriented, gender-specific and culturally sensitive.

Sections 2 and 3 outline why a swift, science-based and people-centered response to the COVID-19 pandemic and its food impacts is needed. Section 2, "WHY addressing the COVID-19 challenge requires a science-based approach: The research challenge," argues the need to harness knowledge for emergency response and recovery in highly accessible ways, recognizing that we must learn from previous crises and rapidly synthesize learning from the current crisis. Section 3, "WHY agricultural research is critical: Unprecedented disruptions and impacts of COVID-19," outlines the stark choices governments are facing in responding to the pandemic, with both health and economic impacts harming poor people and countries the most and LMIC governments constrained in their ability to galvanize the needed resources.

Section 4, "WHAT CGIAR is delivering in response to COVID-19: The research offer," sets out what CGIAR can do, and is already doing, to respond to the COVID-19 pandemic, based on funder and country demand and CGIAR's comparative advantages. Regarding disease control, CGIAR takes a "One Health" approach, recognizing that the health of humans, animals and environments are interdependent. Regarding food systems, CGIAR supports pro-poor policies designed to transform food systems and the people most critical to their functioning—smallholder farmers, herders and fishers, food processors and sellers and women and young people in particular. While responses to the coronavirus pandemic are now necessarily focused on mitigating the current crisis and preparing for a subsequent recovery phase, COVID-19 presents unprecedented opportunities for humanity to "build back better," particularly in the global food systems that lie at the root of the pandemic.

Finally Section 5, "HOW we work with others," lays out how CGIAR will help advance country, regional and global efforts to respond to the COVID-19 pandemic in developing countries, particularly by protecting food and nutrition security and supporting public health. Overcoming this crisis will require highly coordinated teams working across many sectors. CGIAR will join its many partners in helping to determine what exactly "building back better" looks like for the developing world's food, land and water systems and how they protect the health and livelihoods of the poor and vulnerable. CGIAR will use its convening power to work with partners at all levels in adopting approaches that prioritize flexibility, contextualized understanding and timely, two-way communications.

2. WHY addressing the COVID-19 challenge requires a science-based approach: The research challenge

The COVID-19 pandemic, and the many responses to it, are disrupting global economies and livelihoods as well as individual and public health. Nations, international and non-governmental organizations (NGOs), community groups, private companies and individuals of all kinds are all racing to respond to the crisis, with actions and plans that range from immediate crisis responses, through recovery programming, to longer-term resilience strategies to "build back better". These groups and individuals are seeking quick advice on how best to manage the trade-offs associated with any given decision. Only highly collaborative work is likely to ensure comprehensive, effective and efficient responses. Here we outline the research challenges in this work to identify roles that CGIAR can and should play in responding to the COVID-19 pandemic.

a) Key challenges

Key messages:

- The COVID-19 pandemic is exposing weaknesses in every nation's disease preparedness, socioeconomic equity issues and levels of resilience. Because addressing these challenges requires cross-sectoral solutions and multi-stakeholder partnerships, CGIAR's research contributions will be tailored to align with other responses under development or those already in place.
- Because responses to the COVID-19 pandemic, including CGIAR options, will necessarily incur hard trade-offs, CGIAR will provide policymakers with the robust scientific evidence they need to inform their decisions.
- The COVID-19 pandemic is just one of a series of emerging zoonoses becoming more frequent in recent years. CGIAR research can address the drivers of disease emergence and how these can be mitigated to help de-risk food systems.
- Because the pandemic is restricting individual and team movements, both CGIAR research and its information sharing work will make use of "digital- and mobile-first" communications and engagement methods, tools and platforms.

Spreading fast, the COVID-19 pandemic is exposing gaps and exploiting weaknesses in every nation's **disease preparedness**, socioeconomic equity issues and levels of resilience. Addressing these challenges requires solutions from across our health, economic, food, social, environment, cultural and business sectors. That so **many diverse sectors and actors** must contribute to an effective response to this pandemic necessitates that CGIAR research contributions are well aligned with these, especially those involved in agriculture, which underpins the food, nutrition, income and health security of billions of people.

Given the current large uncertainties regarding the spread of COVID-19, the trade-offs inherent in methods to control it, the differentiated impacts of the disease and the economic impacts and distributional consequences of controlling it, choosing among options to address the crisis is challenging, with any decisions taken necessarily imperfect. Major effort is needed to improve the ability of policymakers to **access the best available scientific research** to help inform their decisions. It is particularly important for all to learn quickly from the consequences–unintended as well as intended, negative as well as positive–of the various responses being made to the crisis. Innovative monitoring systems providing timely and insightful data and feedback are needed, in addition to flexible models that can run scenarios and be adjusted as more precise data become available.

At the same time, **movement restrictions**, from "sheltering in place" to curfews to lockdowns, introduce major challenges to research work. Innovative ways to continue sharing essential

knowledge and information (e.g. through wider use of digital tools by agricultural extension services) must be further refined and implemented.

b) Responses and timeframes

Key messages:

- The short-term crisis-response phase requires high-frequency data and scientific evidence for effective prioritization of actions, many of which affect food and nutrition security.
- In the medium- to long-term recovery and resilience stages, decision makers will need evidence-based knowledge to safeguard food, land and water systems and to prioritize public investments in preparation for potential future disease-related food crises.

In the **short-term crisis-response phase**, policymakers and decision implementers urgently need high-frequency, on-the-ground monitoring data, scientific evidence and quick access to existing analyses. Research evidence is critical to determining and prioritizing effective, gender-sensitive and socially inclusive actions affecting income, food and nutrition security at all levels (household, community, district, national, regional and global) while also maintaining effective health systems placed under extraordinary stress.

In the **medium- to long-term recovery and resilience stages**, decision makers in developing countries will need evidenced-based knowledge to buttress the sustainable productivity and livelihoods of millions of food producers and supply chain actors and to ensure that both rural and urban populations have access to sufficient, safe and nutritious food. This knowledge includes guidance on how to prioritize public investments under conditions of massive need and reduced government revenues. Zoonotic epidemics have emerged from agricultural systems since the dawn of agriculture, and with the global human population continuing to expand rapidly till this century's end, further outbreaks of zoonoses are expected and may well intensify.

c) Approaches to "build back better"

Key messages:

- Implementation of One Health approaches can redress failures in animal and environment health that lead to human diseases and can help prevent, manage and mitigate the impacts of future zoonotic outbreaks.
- Long-term resilience responses should aim to "build back better" rather than let progress on environment and development goals stall or regress. These responses will also need to address inequities further exposed by the COVID-19 pandemic.

Medium- to long-term research that employs a **One Health approach** can redress current failures in animal and environment health that lead to human diseases while also making the changes needed in environments and animal populations to safeguard human health. This research should determine how to best assess infectious disease risks in food systems, how to anticipate transboundary disease outbreaks and how to ensure more universal preparedness (e.g. in water supply). Health, phytosanitary and food systems need to greatly improve overall disease surveillance –both to prevent outbreaks and to respond rapidly to outbreaks that do occur. Assessments and interventions are needed to rebuild ecosystems and to reverse agroecosystem decline.

During the recovery and resilience-building stages, it is vital that progress toward meeting long-term environment and development goals continues. Past crises show that such progress can be reversed in emergency responses to shocks. To **"build back better"**, multisectoral work toward these long-term objectives, including integrated landscape management and transformation of food, land and water systems, must be amplified.

The world's poor and hungry are expected to be hit hardest by this crisis, with adverse effects of both the disease and the social distancing policies implemented underscoring an urgent need for greater livelihood resilience. In LMICs, furthermore, this disease and the methods used to control it, both of which are already compounding people's existing vulnerabilities with additional layers of shocks, are further magnifying some large underlying inequities (e.g. in gender, income, ethnicity).

3. WHY agricultural research is critical: Unprecedented disruptions and impacts of COVID-19

Among the unprecedented health, economic and social harms that COVID-19 is causing communities worldwide, initial studies detail specific severe impacts in China on rural households, small- and medium-sized enterprises (SMEs), livestock production and fish production. Because the impacts of the disease in Africa, South and Southeast Asia, Latin America and the Caribbean, while accumulating quickly, are still at a relatively early stage, current impact assessments are relying on previous experiences as well as emerging on-the-ground information. Through its global network of researchers and partners, CGIAR is already gathering data on the pandemic's significant disruptions to food systems, information that should help to inform the types of response, recovery and resilience interventions that are needed most.

a) The effects of COVID-19 on human health

Key messages:

- While the enormous global health impacts of COVID-19 that are placing health systems under great stress and causing particularly adverse outcomes for some populations, groups and individuals are well known, many fundamental aspects of the disease's direct health impacts (e.g. asymptomatic prevalence, risk factors and death rates) remain unknown as yet.
- Hundreds of research groups are scrambling to develop vaccines, diagnostics and treatments for the new coronavirus, building on earlier work to combat two other diseases caused by coronaviruses—severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).
- Among the wide-ranging indirect harms to human health that the pandemic is causing are reduced health services for people with non-COVID-19 health problems, restrictions in public health programs (e.g. measles vaccine initiatives) and some negative effects of social distancing policies, such as increased gender-based violence and mental health problems.
- While many countries are moving to ease their various lockdown restrictions, there are concerns that doing so may lead to further waves of the pandemic.
- The emergence of COVID-19 is dramatically highlighting the need to learn more about how and where zoonotic diseases originate and how we can better prepare for them in future.
- The direct and indirect effects of COVID-19 on human health are enormous, with unprecedented speed of transmission worldwide and relatively high levels of both morbidity and mortality. Different populations, groups and individuals suffer the disease differently, with mortality rates much higher among the elderly and those with underlying health conditions such as diabetes, chronic lung disease or obesity (which are themselves often outcomes of socioeconomic inequities). The pandemic is putting health systems

in many high-income countries under enormous pressure and the under-resourced health systems in LMICs are likely to experience even greater stress. While public health organizations (e.g. Centers for Disease Control and Prevention, World Bank and World Health Organization) are, together with local and national governments, leading global efforts to respond to the disease this virus causes, the ways in which the disease is impacting economies, food systems and human well-being also need focused attention.

i. Direct effects

Many unknowns remain about the epidemiology of COVID-19 and there are some surprising heterogeneities in the disease's transmission, prevalence and case fatality rates. Full understanding of issues of transmissibility, asymptomatic prevalence, risk factors, death rates, etc., would require randomized testing of human populations at different stages of the pandemic. Some immunity to COVID-19 among those who recover from the disease is likely, but the effectiveness and duration of this protection are unknown. Some populations may experience less disease due to their demography, lack of high-risk co-morbidities, climatic conditions or other as yet unknown protective factors.

Hundreds of research groups are currently working to develop vaccines, diagnostics and treatments for the disease, building on work to develop vaccines for two related coronavirus diseases that emerged earlier–SARS and MERS. Many treatments for COVID-19 are already under trial and a few, like the investigational antiviral drug remdesivir, have been authorized on compassionate grounds for emergency use in those with severe disease. It is possible, though far from certain, that effective therapeutics will be available in several months and a vaccine or vaccines in one to two years. However, even when developed, providing access to therapeutics and vaccines to the developing world's populations will present an additional challenge.

ii. Indirect effects

With non-essential procedures delayed and some patients delaying hospital visits for fear of contracting COVID-19, doctors warn of a silent sub-epidemic of people who need healthcare for issues such as inflamed appendices, infected gall bladders, chest pains and stroke symptoms. Previous experiences have shown that when health systems in LMICs get disrupted, malaria cases increase. A heavy focus on COVID-19, plus potential diversions of health resources to combat it, could derail existing programs targeting tuberculosis, acquired immunodeficiency syndrome (AIDS), measles and malaria in places like the Democratic Republic of the Congo. Even for people with symptoms of COVID-19, confidence in whether their healthcare system can treat them, and how much it will cost, will affect their choices regarding whether and how to seek medical help.

The impacts of COVID-19 on other sectors (e.g. agriculture, manufacturing, education), public programs and investments will depend on the extent to which countries are able to control the spread of the novel coronavirus and reduce its direct impacts on human health. More data and diagnostics are needed on both the impacts of the pandemic and the effectiveness of different actions taken to address its direct and indirect effects.

There is a high degree of heterogeneity in how countries are responding to COVID-19, in the impacts the disease is having on the health of their populations and in responses of communities to government-imposed restrictions. Moving forward, the health and economic responses made by countries will be determined largely by how effective their control measures are and how long the pandemic lasts.

Movement controls and social distancing may have adverse indirect health effects on both rural and urban communities. Among these are an increase in mental health problems (particularly among healthcare workers) and health conditions worsened by a lack of physical exercise, gender-based violence, gender inequalities and breakdowns in community and public health

programs for childhood immunizations and maternal and child health and nutrition. For people in LMICs, lockdown restrictions may reduce their likelihood of contracting COVID-19 but also hurt their livelihoods and result in extreme food insecurity. The World Food Programme (WFP) estimates that 368 million children globally are currently[1] missing out on meals at school. Over 117 million children in 37 countries may miss out on receiving the measles vaccine. Measles immunization campaigns in 24 countries have already been delayed. Because women are often responsible for daily household shopping, cooking, cleaning and water and firewood provision, they may experience greater exposure to unsafe environments or crowds. Basic precautions against COVID-19 (e.g. frequent hand washing, social distancing, etc.) will be out of reach for many people in developing countries–in 2017, two billion people lacked access to basic sanitation facilities. Climate events such as droughts and floods will further reduce people's access to safe water.

iii. Reactions to government responses and lockdowns

As movement restrictions endure, frustrated citizens have protested the lockdowns implemented in Brazil, India, Malawi, Nigeria and South Africa. Citizens have protested not only the restrictions but also the harsh way some are enforced. As food insecurity mounts, in regions where fresh meat, fish, vegetables and other "wet market" products serve as the only alternative to restricted, formal food sources, increased human-wildlife contact and/or reliance on food markets which pose higher food safety or health risks could have both local and global ramifications.

While countries are primarily focusing on their crisis response, attention is expanding to where human (and animal) epidemics and pandemics come from, why they are occurring more frequently and how we can better prepare for them in future. The management of, and interface with, environments where wild animals are found, combined with farming practices of domestic and, increasingly, wild animals, have direct consequences for human health. Approximately 75% of novel human infectious diseases emerge from wildlife and many of the most important (e.g. swine influenza, Rift Valley fever) have undergone an amplifying stage in domestic livestock.

b) The effects of COVID-19 on food and nutrition security

Key messages:

- The economic fallout of COVID-19 could increase the number of people in extreme poverty by 20%, equivalent to 140 million people falling into extreme poverty in 2020—80 million of them in Africa.
- Reductions in incomes will likely cause people to reduce their spending on food, particularly nutritious food, with particularly adverse effects for women and children.
- In terms of productive assets, COVID-19 is having the biggest effect on labor due to lockdowns and other restrictions. While both the formal and informal sectors are affected, the latter is likely to fare worse. Other factors in income losses include reduced remittances, migration to rural areas and a collapse in tourism.
- COVID-19 is affecting food value chains, due not only to a lack of available labor but also to increased prices of inputs, some export bans and restrictions on local market trading. These effects are largest in the value chains of higher-value, perishable products.
- COVID-19 is compounding existing problems for food value chains, such as the current desert locust invasion in East Africa.

Unemployment and increasing poverty will lead to reductions in food consumption and nutritional status, particularly for the poor, who typically spend 30–80% of their income on

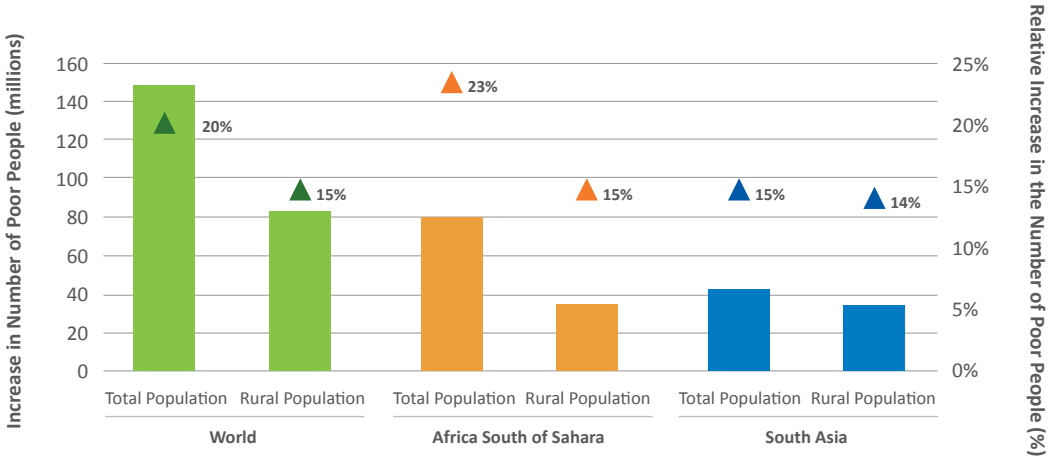
[1] Data retrieved 13 May 2020.

food, rely on subsistence farming and small-scale, informal value chains and may already be experiencing nutritional insecurity. Women and children are typically the first to reduce food consumption in a crisis and will be adversely affected. WFP has warned that the COVID-19 pandemic could almost double the number of people suffering acute hunger, pushing the number to more than a quarter of a billion by the end of 2020.

i. Increasing poverty and its impacts on food and nutrition security

Without unprecedented emergency relief, the economic fallout of COVID-19 could increase the number of people in extreme poverty by 20% (Fig. 1), which is equivalent to 140 million people falling into extreme poverty in 2020—80 million of them in Africa. Throughout both the developed and the developing worlds, many individuals are already experiencing reduced incomes and economic hardship. In Bangladesh, a rapid perception survey of 2,675 low-income households undertaken from 31 March to 5 April 2020 indicated that extreme poverty has risen by 60%. While the expected global economic recession will cause economic harm to most people, it will have the largest effect on poor people's incomes.

Figure 1. Impact of COVID-19 global economic crisis on extreme poverty.



Source: IFPRI, Authors based on simulations with MIRAGRODEP model.

Whether through falling incomes, rising food prices, or both, people will have less real income to pay for their food and will adjust accordingly by purchasing the cheapest calories they can find. In poor countries, calories from nutrient-rich foods like fruits, vegetables, milk, fish, meat and eggs can be up to 10 times more expensive than calories from staples such as rice, maize, wheat or cassava.[2] In the face of drastic declines in income, vulnerable households will quickly give up nutrient-rich foods in order to preserve their caloric intake. A study of rural migrants in China demonstrated these effects after just one month of travel restrictions, with estimated losses of over USD 100 billion to China's economy. As a result of lost wages, families reported reduced spending on food, buying more grains and staples in bulk at low cost instead of more expensive goods like meat and produce.

ii. Factors affecting incomes

In terms of productive assets, COVID-19 is having the biggest effect on labor, within both the formal and informal sectors. Lockdowns and other restrictions are resulting in widespread

[2] Headey, D.D. & Alderman, H.H. (2019). The Relative Caloric Prices of Healthy and Unhealthy Foods Differ Systematically across Income Levels and Continents. *The Journal of Nutrition* 149(11): 2020–2033.

unemployment and the International Labour Organization anticipates cutbacks equivalent to nearly 200 million full-time workers during April–June. This badly impacts the poorest, for whom labor is often their principal asset. Poor people who must travel for work (e.g. landless workers who travel to work in seasonal jobs such as harvesting) and service workers in low-paying jobs (e.g. in foods service and tourism) are the hardest hit by COVID-19 restrictions. In the United States, 30 million workers filed unemployment claims between 14 March and 25 April 2020, while in Bangladesh, an estimated 1 million garment workers were fired or furloughed due to declining global orders. In sub-Saharan Africa, SMEs in the retail trade, sewing, handiwork manufacturing and taxi/motorcycle services make up more than two-thirds of urban employment and will be unlikely to weather more than a few days of lockdowns. School closures and/or sick household members will reduce the ability of women, who are often the primary caregiver in families, to earn a livelihood. The informal sector, which does not provide compensation, buffers or adjustments, is also likely to be heavily affected. In Africa, for example, governments have a history of crackdowns on informal traders, who are disproportionately women, particularly during public health outbreaks.[3] Many of these newly unemployed people are moving to rural areas where, on the one hand, they may increase agricultural production while, on the other, they are putting downward pressure on wages.

For people in LMICs, remittances also play an important role, serving as a vital source of income, particularly for the South Asia, East Asia and Pacific regions. In 2019, remittance flows to LMICs reached USD 554 billion, more than double the amount of overseas development assistance. Historically, remittances would increase during times of crisis in origin countries. However, due to the economic crisis resulting from the COVID-19 pandemic, widespread unemployment and logistical difficulties in transferring cash, the World Bank now estimates that global remittances will decline by about 20%, or USD 445 billion, in 2020. This reduction will have significant implications for countries like Lebanon, which generates 12% of its gross domestic product (GDP) from remittance payments. Any remittances that are received are likely to be diverted from investments in productive assets, like improved seeds, to basic survival items, like food and medicines.

The collapse of tourism is another source of economic decline. Egypt, for example, generates 14.5% of its GDP from tourism, remittances and Suez Canal revenues. For each month that the COVID-19 crisis persists, models suggest that Egypt's national GDP could fall by between 0.7–0.8% (USD 2.3–2.6 billion). Under this scenario, rural poor households are estimated to lose 11.5–14.5% of their average income, while urban poor households will see their average income decline by 9.7–11.5%.

iii. Disruptions to food value chains

One of the immediate reactions to the COVID-19 pandemic was a change in exchange rates, which can increase the costs of farming inputs and other imported goods. While lower exchange rates of national currencies with respect to the US dollar are often driven by lower prices for non-food commodities (e.g. oil, platinum, palladium, silver, and copper), they have a knock-on effect on all tradables, including food and agriculture products. As a result, domestic consumers may experience rising food prices and changes in the quantity or type of food available if their currencies depreciate relative to the US dollar. This is particularly true for countries that rely heavily on food imports to meet consumption demands, such as the Democratic Republic of the Congo, Small Island Developing States, Somalia, Sudan, the Syrian Arab Republic and Yemen.

Highly specialized agricultural supply chains and small-scale food producers in developed countries are being affected by abrupt drops in demand (e.g. reduced tourism and restaurant closures disrupting seafood supply chains) and movement restrictions. In developing countries, agricultural supply chains are more labor intensive and will be affected by COVID-19 and its associated movement restrictions. Labor shortages are starting to impact food producers,

[3] Resnick, D. (2019). The Politics of Crackdowns on Africa's Informal Vendors. *Comparative Politics* 52(1): 21–51.

processors, traders and logistics companies—particularly labor-intensive SMEs. The impact is less, but in some circumstances still substantial, in developed countries, where supply chains are more automated. These effects would be enormously exacerbated if countries enact export bans, as seen during the 2007–2008 food price crisis. While 11 countries currently[4] have binding, active export bans, this is much lower than the 33 countries that implemented bans during 2007–2008 and accounts for just 5% of the world market of calories, compared to 19% in 2007–2008.

Early evidence from Ethiopia suggests that the COVID-19 pandemic is already affecting vegetable value chains: both trade and consumption are reduced; farmgate prices are declining, although there is little change in urban retail prices; farm losses are iincreasing, with vegetables fed to livestock or left to rot due to a lack of demand and inputs are more expensive and in short supply. While these effects are not yet well understood, they are likely to have the biggest impacts on the poorest and most vulnerable food producers and consumers. Women may be particularly affected, as they are often in charge of household food consumption and may have to spend a greater amount of time sourcing food.

In Madagascar, the government has imposed night curfews and restricted market trade. The government of Nigeria also closed several food markets in Lagos and imposed limits on trading times in others to only four hours every other day. Small-scale food producers are facing logistical struggles due to mobility restrictions, production losses and reduced sales. Shortages of inputs (e.g. seeds, fertilizer) are also anticipated, which will lead to product shortages and price increases.

Farmers in sub-Saharan Africa are already tackling the worst desert locust invasion for a quarter of a century. There are concerns that movement restrictions may hinder efforts to control the locust infestation, with large impacts on crop production. Similarly, movement restrictions are likely to impact farmers' access to high-quality seeds of improved crop varieties, particularly where seed systems are informal. Social distancing also reduces the opportunities for collective action (e.g. sharing labor for tasks) and for agricultural extension activities such as group trainings.

c) Social safety nets constrained by limited fiscal capacity

Key messages:

- The world is very likely to face a deep recession in 2020, with poorer nations facing significantly greater adversity through lower demand for trade and lower commodity prices.
- Lockdown restrictions are causing even greater disruption to agri-food systems than the global economic shocks, resulting in GDP declines of 30–40% for some LMICs during lockdown periods.
- Social safety programs serve as lifelines for the poor in many countries, but these are limited by falling government revenues and large foreign debts. Governments are adapting or introducing large numbers of social protection initiatives, though in time these may be replaced by more traditional, production-side interventions. The needs of women and vulnerable populations should be considered when planning and implementing both short- and long-term initiatives.

In many countries, the impacts of reduced incomes are often mitigated through social safety programs that serve as lifelines for many poor and vulnerable populations. Small businesses operating in the agri-food system, which often employ most of the working poor, may also receive government support, such as subsidized inputs and credit. For the people and places left behind, mixes of humanitarian program and development interventions will be important but are constrained by the limited fiscal capacity and high debt of governments.

[4] Data retrieved 13 May 2020.

i. Depressed economic activity due to global shocks and lockdown restrictions

The world is very likely to face a deep recession in 2020–at least as severe as the one following the global financial crisis of 2008–2009. Using a global model developed by the International Food Policy Research Institute (IFPRI), Laborde et al. (2020) examined some of the likely impacts of the downturn for poverty, both worldwide and regionally, to project a downturn in global economic growth of 5% in 2020. This projection is broadly similar to a recent forecast by the International Monetary Fund, which shows a downturn of the world economy from pre-pandemic 2–3% anticipated growth to an actual decline of 3%.

This same model, however, indicates that the poorest nations will face significantly greater adversity. The recession that has already started in Europe and the United States is projected to depress economic activity across developed countries by 6% on average in 2020, despite an expected rebound later in the year as social distancing measures are lifted and stimulus measures take effect. This recession will spill over to the rest of the world through lower demand for trade and lower commodity prices. Countries home to the world's 135 million acutely food-insecure people will face greater challenges as they have limited or no capacity to cope with either the health or socioeconomic aspects of the shock.

In many countries, however, major disruptions to agri-food systems are being caused not by shocks emanating from the global economy but rather by these countries' own lockdown restrictions and social distancing policies. IFPRI's country models estimate that national incomes will drop sharply during the second quarter of 2020. In Kenya, Myanmar, Nigeria, Rwanda and South Africa, for example, the models estimate that total GDP will decline by 30–40% during these countries' lockdown periods. Although restrictions will eventually be eased, they will have lasting effects as small businesses go bankrupt and households are forced to sell assets to smooth their consumption levels. IFPRI's models estimate that many countries will begin 2021 with lower incomes and fewer jobs than at the start of 2020, a deficit at least partly determined by the implementation of social protection programs and emergency stimulus packages.

The pressure on governments to provide social protection and stimulus packages is mounting, but at the same time, government revenues are falling as economic activity declines at home and demand for exports falls sharply. In Nigeria, for example, the government has projected a decline of USD 4 billion in revenues this year and has said that public investment programs will need to be scaled back. Moreover, unlike in the 2008–2009 global financial crisis, many developing countries today have accumulated large foreign debts. These looming debt burdens, already a concern before COVID-19, will make it difficult for governments to finance humanitarian and economic recovery programs by borrowing. Most countries are currently operating in "spending mode" rather than worrying about revenues, with this spending largely on the back of large World Bank funding in the form of short-term grants and pandemic emergency financing.

ii. Public programming responses to COVID-19

Governments will need to repurpose and redirect current policies and public programs to make them more effective and to expedite economic recovery. As of 8 May 2020, 171 countries had adapted or introduced 801 social protection initiatives in response to COVID-19, though these short-term economic responses have varied greatly in scope and ambition. In Ethiopia, the planned aid package totals 0.15% of GDP, while Rwanda's package stands at 1.5% of GDP. By contrast, the United States and South African stimulus packages are equivalent to about 10% of GDP.

Social protection is a narrow policy instrument and as countries move into the recovery phase, governments may revert to more traditional production-side interventions, with reduced focus on social protection. During the emergency response, social assistance transfers are being used most widely (61% of global responses). In Kenya, for example, the government is planning to

roll out large transfers focused on women and children, facilitated by an announcement by the Kenyan mobile network operator Safaricom that it will waive fees for most transactions for three months. With the focus on emergency response, gender considerations have generally not been at the forefront of these efforts and most existing social protection programs in LMICs are either gender blind or gender neutral. Due to the digital gender gap that remains in many countries, women and girls may find it harder to access social safety nets if they are implemented via digital transfers. A rapid assessment of initial COVID-19 social protection responses indicates that only 11% show some (albeit limited) gender sensitivity. Meanwhile, displaced people living in refugee camps are particularly vulnerable to both the health and economic impacts of the COVID-19 pandemic, yet their status may exclude them from social protection packages. With currency depreciation, movement restrictions and health and safety concerns, humanitarian aid organizations may find it difficult to implement programs and their costs may increase.

d) Demands for short-, medium- and long-term responses

Key messages:

- Various CGIAR funders and expert sources have urgently called for knowledge and evidence to inform coordinated tasks and responses, both in the short-term crisis phase and as we move toward longer-term resilience and preparedness.

As a result of these disruptions, various CGIAR funders (e.g. United Kingdom's Department for International Development, United States Agency for International Development (USAID)) and expert sources (e.g. the European Centre for Development Policy Management, Food and Land Use Coalition, Global Panel on Agriculture and Food Systems and Nutrition, Overseas Development Institute, World Farmers' Organization) have urgently called for knowledge and evidence to inform coordinated tasks and responses, ensuring that expertise is leveraged from all corners and efforts are not duplicated. While short-term crisis and then recovery responses are essential, it is also vital to consider countries' longer term resilience and preparedness as we continue to work toward meeting the 17 UN Sustainable Development Goals.

4. WHAT CGIAR is delivering in response to COVID-19: The research offer

a) CGIAR strategic advantage in responding to COVID-19 challenges

Key messages:

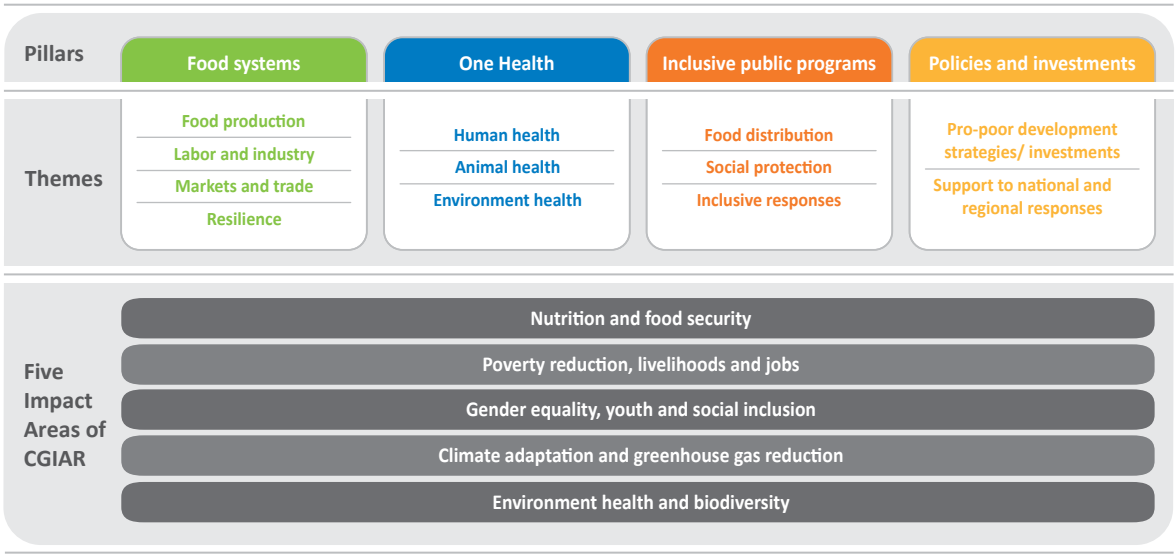
- CGIAR has a strong portfolio of work on issues related to the causes and consequences of the COVID-19 crisis in relation to food, land and water systems, including through One Health approaches.
- In coordination with global, national and local partners, CGIAR has responded by actively sharing its existing and emerging knowledge and experience to address the challenges posed by COVID-19.
- Around two-thirds of the CGIAR Research Portfolio 2020–2021 has immediate relevance to the COVID-19 response and all CGIAR research is relevant to global efforts to "build back better".
- The CGIAR work of highest relevance encompasses four research pillars: (i) Food systems; (ii) One Health (the human-animal-environment health interface); (iii) Inclusive public programs for food security and nutrition; and (iv) Policies and investments for crisis response, economic recovery and improved future resilience.

- At the country level, CGIAR is supporting government responses to COVID-19 by working with local partners to monitor markets and advise on appropriate policies, with an emphasis on mitigating COVID-19 impacts on the most vulnerable members of society.
- At the global level, CGIAR is working together with United Nations (UN) agencies and other development partners, for example by carrying out phone-survey-based assessments for understanding the impacts of COVID-19 on rural household livelihoods and food security.

Existing models, tools and evidence are already being mobilized by CGIAR to help countries cope with the effects of the pandemic, while pivoting the current CGIAR program of work to address the emerging challenges. Economic analyses for targeted policy response, monitoring of trade policy measures and market volatilit and delivery of targeted technologies and tools that increase input-use efficiency and are appropriate to various groups of farmers are at the forefront of the emergency response and will remain important during the recovery phase.

i. Pillars of COVID-19-relevant CGIAR research

The health, economic, food, land and water systems research needed to address the impacts of COVID-19 in LMICs can be structured by **four pillars of CGIAR research: (i) Food systems; (ii) One Health (the human, animal and environment health interface); (iii) Inclusive public programs for food security and nutrition; and (iv) Policies and investments for crisis response, recovery and improved resilience.** Some current CGIAR research is already highly applicable to COVID-19. Other CGIAR research can be adapted using existing resources to inform the current situation. Still other avenues of research can be rapidly developed to address novel problems facing food systems as a result of COVID-19. The response proposed in this paper is therefore a combination of applying solutions readily available from previous and ongoing CGIAR research to respond to the emergency with immediate action and additional research to mitigate disruptions in the agri-food systems, contribute to the recovery and boost longer-term resilience.



Food systems: The COVID-19 pandemic is, both directly and indirectly, impacting the complex web of activities surrounding food production, storage and transport, processing, retailing and consumption. Both the supply and demand sides of food systems are being disrupted, with potential knock-on effects for critical supply chains and markets. CGIAR research will enhance food and nutrition security in the immediate response to COVID-19 and the subsequent recovery period. Research will focus on the opportunity presented to "build back better" in terms of land and water management in high-priority geographic areas – particularly in response to climate adaptation and mitigation, but also in terms of preventing the next zoonotic disease outbreak. Research themes are food production, labor and industry, markets and trade and resilience.

One Health: The origins of COVID-19 and other recent zoonotic epidemics link the research themes of human, animal and environment health (i.e. the three tenets of One Health). Many pathogens have emerged from animals and mutated to cause epidemics spread mainly by human-to-human contact. Viral infections (e.g. influenza, hemorrhagic fevers and coronaviruses from bats) have been particularly prominent in recent years. While emergence of new diseases of animal origin in humans has occurred for millennia, conditions for establishment and spread in humans have increased. Three main issues are relevant. The first is that, driven by rapid population growth, people, domestic animals and wildlife increasingly share overlapping habitats, including forests, savannas and cities. The second is that there is an increasing number and density of domestic animals, which can amplify potential epidemic pathogens and provide more transmission opportunities to humans. Finally, human population density and movement facilitate pathogen transmission. CGIAR will support immediate One Health responses to the COVID-19 crisis, identify opportunities to prevent other zoonoses from emerging or spreading in future and research ways to improve detection of and response to emerging and endemic zoonoses.

Inclusive public programs: The survival and well-being of poor people will depend on smart public programs encompassing food distribution; water, sanitation and hygiene programs; social safety nets; and inclusive responses that are gender-sensitive and support vulnerable groups. What programs should be prioritized and how these are best planned, delivered and adapted are critical questions for research to address, given the limitations of public finance in most countries. CGIAR has considerable experience in evaluating a range of public programs that could be effective for COVID-19 response and recovery and post-COVID-19 resilience in a variety of fragile contexts to support people and communities that would otherwise be left behind. Under three research themes, (i) food distribution, (ii) social protection and (iii) inclusive responses, CGIAR responses will help to mitigate food and nutrition insecurity among vulnerable populations through analyses and policy advice on cash transfers, agricultural input programs, food distribution, nutrition supplementation and rural employment.

Policies and investments: In LMICs, food and agriculture are major sectors employing a high proportion of people and impacting the food and nutrition security of all. National governments will need to co-manage agricultural, health, economic and social policies and investments. Prioritization and rapid learning at multiple levels, related to specific contexts of regions, countries and important sub-regions, will be essential given the coordination and fiscal challenges and wide-ranging consequences of COVID-19 over the short to long terms. CGIAR will generate evidence-based policy and investment solutions for the food, land and water systems and rural development generally that are needed to respond to the crisis under two research themes, (i) pro-poor development strategies/investments and (ii) support to national and regional responses.

Links between the COVID-19 research themes and the CGIAR ***impact areas: (i) nutrition and food security; (ii) poverty reduction, livelihoods and jobs and (iii) gender equality, youth and social inclusion,*** in addition to research focused directly on these topics as outlined in this section, are explained in Appendix 1. The research response to COVID-19 includes natural resources and ecosystem services as part of the food systems (resilience) and One Health (environment health) pillars.

ii. The relevance of the CGIAR Research Portfolio 2020–2021 to COVID-19

To assess the extent to which current CGIAR research is already supporting efforts to meet the COVID-19 challenge, the CGIAR Research Portfolio 2020–2021 was mapped against the research pillars and the themes proposed above. Milestones in each of the CGIAR's 12 Agri-Food Systems and Global Integrating Programs (as included in the plans of work and budget for 2020 submitted in January 2020, before the onset of the COVID-19 crisis) were assessed for their relevance to each of the COVID-19 research themes using lighter to darker shades of color to denote lower to higher degrees of correspondence. The resulting heatmaps (available here) help to identify both strengths and gaps in response to the COVID-19 pandemic.

All CGIAR Research Programs (CRPs) are already delivering relevant work supporting national and regional responses to COVID-19 in the short, medium and long terms. Almost two-thirds of all milestones in the current CRP portfolio address two or more of the COVID-19-relevant research themes, demonstrating that a lot of ongoing work will benefit countries affected by the crisis. Of the research themes identified above, the ones most prominently represented in the current CRP portfolio fall under: (i) Food systems: **food production and resilience;** (ii) One Health: **animal health;** (iii) Inclusive public programs: **inclusive responses;** and (iv) Policies and investments: **pro-poor development strategies/investments and support to national and regional responses.** All of these are conducted in a broad systems approach recognizing the interlinkages among food, land, water and health systems in a climate crisis. Almost half of all the milestones contribute to national and regional responses by working closely with national agricultural research and extension system (NARES) partners and the majority of milestones have a strong resilience component, contributing to the efforts to "build back better".

As an immediate priority within ***food systems***, during the COVID-19 pandemic and its aftermath, CGIAR continues to contribute to ensuring sufficient and diverse food supplies. Agricultural technologies and tools that increase the efficiency of input use and are appropriate to various groups of farmers are at the forefront of the emergency response. Seed distribution, as a starting point for food production, has a prominent place in CGIAR research as part of many crop-related CRPs. Crop health research to reduce losses generated by existing or emerging pests and diseases also helps to mitigate additional stresses in the agri-food systems in light of COVID-19. Moreover, many CRPs are testing innovations to reduce pre- and post-harvest losses at the farm and other parts of the value chain to ensure sufficient food supplies. Specific examples are provided in Appendix 2.

Recognizing the critical importance of boosting human health and nutrition during the global COVID-19 pandemic, CGIAR is working with partners to maintain focus on nutrition-sensitive production and adequate supplies of food. The ongoing joint research of several CRPs has demonstrated the value of multidisciplinary approaches for enhancing the resilience of food systems to multiple shocks, such as research on small-scale fisheries resilience and its nutrition, employment, income and social security safety net functions. As already demonstrated in the COVID-19 crisis, resilient food systems also depend on taking systematic approaches to food system transformation that link health, sustainability and socioeconomic outcomes (e.g. equitable income and inclusion).

Within ***One Health***, tools are being developed and applied to assess the significance of animal pathogens and commensals and the risk of the emergence of newly mutated ones, as well as diagnostics and vaccines to improve their control. Of particular relevance to COVID-19, Flagship 5 "Improving Human Health" in the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) brings together animal health and public health communities to address One Health challenges. Strengthening biosecurity at both farm and market levels is another core area of work that directly contributes to addressing the COVID-19 challenges in the medium to long term.

During this COVID-19 pandemic, there is increasing demand for safe, processed foods that can be easily stored and marketed to reach large numbers of rural and urban poor through general markets, as well as in food distribution programs. Several CRPs are delivering knowledge and support in this area. CGIAR work is also focused on consumers and the current portfolio includes developing and testing retailer- and consumer-oriented interventions to improve fruit and vegetable intake. Large ongoing food safety projects in informal value chains (e.g. milk in Kenya, chicken in Ethiopia, vegetables in Burkina Faso, meat in Uganda, pork and dairy in India, meat in Cambodia and pork in Vietnam) complement this work (Appendix 2). These informal markets supply most people in LMICs and have been associated with the emergence of diseases and are a major source of foodborne disease.

Environment health, as an integral part of One Health, remains a major priority that is reflected in CRP milestones. CGIAR work in this area has helped address multiple sources of risks and improve the abilities of communities and local governments to react to both the COVID-19 pandemic and, for example, floods, droughts and other natural hazards.

Inclusive public programs are increasingly integrated with other development actions to support people left behind. Within the COVID-19 crisis phase, public programs will play a role in immediate crisis response and in medium- to long-term recovery and resilience efforts. The work of CGIAR in this area focuses on guiding program formulation and implementation to protect vulnerable populations facing additional risks of poverty and malnutrition. This includes studies on the effects of social protection programs that incorporate countries and regions where there has been, or continues to be, conflict and other shocks that disrupt economies. CGIAR research helps to highlight areas of vulnerability and to map local food systems so as to understand coping mechanisms, which are often embedded in informal and social structures. CGIAR work to alleviate shocks to urban food supply by improving the functioning of domestic markets and food distribution is key to safeguarding food and nutrition security during the COVID-19 crisis (Appendix 2).

Within ***policies and investment***, CGIAR is capitalizing on its strong competencies in economic analyses for pro-poor development strategies/investments and national and regional responses, including both ex ante assessments of the impacts of shocks and the scientific and social innovations needed for addressing food system vulnerabilities to withstand these shocks. Decision tools that can help assess, understand and anticipate food supply shocks caused by COVID-19 and design appropriate policy responses require monitoring of crop harvests and identification of food supply shocks, which is work undertaken by many CRPs (Appendix 2). The immediate analytical response of CGIAR to the COVID-19 crisis lies within these areas.

An example of support at the **country level** is CGIAR work with the government of Bangladesh to respond to COVID-19. This support encompasses a multitude of actions, from monitoring food, labor, input and feed supply and prices, to advising on policies to mitigate the impacts of shocks on the most vulnerable groups (Box 1). CGIAR is also strongly engaging in the ongoing collaboration with NARES in Ethiopia with a focus on enhancing food systems and building resilience in agriculture (Box 2).

Box 1: One CGIAR support for countries addressing COVID-19 challenges: Example from the People's Republic of Bangladesh

CGIAR coordinates and mobilizes research capacities across its system to respond to country-specific needs, as demonstrated by its support of COVID-19 responses in Bangladesh. CGIAR Research Centers including the International Maize and Wheat Improvement Center (CIMMYT), IFPRI, the International Rice Research Institute (IRRI) and WorldFish, are galvanizing the following kinds of work to support government programs being implemented to cope with the pandemic.

- Evidence-based advice on appropriate policies and technologies to support "rabi" season crop harvests, processing and food supply, in addition to "kharif-I" and "kharif-II" planting.
- Crowdsourced data and information on the supply of, and demand for, essential agricultural inputs (i.e. fertilizers, fuel, pesticides, veterinary products).
- Policy and economic advice on how to maintain a smooth flow of trade, including making full use of the international market to secure food supply and meet demand.
- Advice on relief efforts, particularly on foods to include in household food aid distribution programs to ensure nutritious and safe diets and long-term food storage.
- Technical advice and support for logistical operations to maintain safe food supply chains.

- Monitoring of food, labor, input and feed supply and prices.
- Advice on issues related to wet markets and the livestock-wildlife interface, including how to mitigate future zoonotic disease outbreaks and support One Health approaches.
- Assessments of the impacts of the COVID-19 crisis on small- and medium-sized agribusinesses and advice and support for ways to overcome business disruptions.
- Determining ways to mitigate risks to Bangladesh's trajectory of poverty reduction.
- Technical and logistical support for initiatives aiming to increase local food production so as to increase resilience and mitigate social disruption.

Box 2: Ethiopia-CGIAR partnership supporting Ethiopia's food system transformation

Ethiopia and CGIAR have a long history of cooperation. The Ethiopian government has a vision for transforming its country with a strong focus on enhancing food systems. With multiple agriculture, food, nutrition, climate and natural resource strategies guiding their objectives, the government collaborates closely with a range of partners to bring together the necessary knowledge, capacities and delivery pathways for their implementation.

Ethiopia's NARES has multiple institutes and programs and a decentralized structure. There are also long-term partnership arrangements between CGIAR and key NARES partners such as the Ethiopian Institute of Agricultural Research and the Agricultural Transformation Agency. CGIAR also has rich partnerships with Ethiopian universities.

Multiple CGIAR Research Centers are operating from a single campus under a hosting arrangement between ILRI and the Ethiopian government, alongside other programs and organizations such as the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), The CGIAR Research Centers provide services for many CGIAR partners, such as the Bill & Melinda Gates Foundation, the IFAD, the Alliance for a Green Revolution in Africa (AGRA) and the International Centre of Insect Physiology and Ecology (ICIPE). This provides a critical mass of CGIAR and partner expertise as a key source of long-term support to Ethiopia's agriculture and food system transformation. These long-term partnerships form a foundation for providing urgent support during shocks, such as from COVID-19, drought or locust invasions.

As part of the COVID-19 response, some specific examples of how CGIAR is supporting Ethiopia with its response to COVID-19 across the four pillars of research include:

- ***Food systems:*** e.g. CGIAR is helping to conduct initial assessments of food security and nutrition, perishable food supply and the dairy value chain.

- ***One Health:*** CGIAR is conducting several projects with the Ethiopian Public Health Institute and Addis Ababa University on food safety and antimicrobial resistance.

- ***Inclusive public programs:*** CGIAR is conducting phone surveys of household resilience in Ethiopia's Productive Safety Net Program districts.

- ***Policies and investments:*** CGIAR is assessing the economic and food security impacts of COVID-19 in Ethiopia (available on request).

For example, CGIAR is a key driver of the USAID-funded Africa Rising program. As part of this program, CGIAR is working, through action research and development partnerships, in the

Ethiopian Highlands, creating opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems. This work takes place in four regional states of Southern Nations, Nationalities and Peoples, Amhara, Oromia and Tigray.

The Ethiopia-CGIAR partnership provides an excellent model for strengthening other CGIAR-country partnerships. It is built on long-term government ownership and leadership of agriculture and food sector development and long-term partnerships with key Ethiopian research and development institutes. Such strong research partnerships have contributed to Ethiopia's efforts to transform its agriculture in the last two decades, to lift millions out of severe poverty and to increase the resilience of its people, who are now better prepared to cope with shocks such as COVID-19.

At the **global level**, CGIAR is working with UN agencies and other development partners. For example, a collaboration with IFAD is exploring phone-based survey assessments to understand the impacts of COVID-19 on rural household livelihoods and food security, while the International Livestock Research Institute (ILRI) is working with the WHO to better control sleeping sickness, an emerging disease with a zoonotic interface.

b) Pivoting the current CGIAR program of work

Key messages:

- Additional CGIAR country-specific support will be mobilized in the short term by **pivoting some of CGIAR's current program of work.**
- CGIAR work will be reoriented to address COVID-19 issues by communicating, **mobilizing and adapting existing models and other tools and solutions.**
- Such pivoting of 2020–2021 CGIAR research is achieved in three ways: (i) **Incorporating COVID-19 as an analytic factor** in existing lines of research; (ii) Leveraging **existing projects focused on technology and institutional strengthening** in selected countries and regions and (iii) Reallocating resources that cannot now be deployed for field work and travel (concrete examples are provided in Appendix 3).

To mobilize resources for an immediate response to the COVID-19 pandemic, CGIAR research can be implemented by pivoting its existing resources allocated during 2020–2021 to the CRPs under Window 1 (portfolio investments supporting CGIAR as a whole) and Window 2 (program investment) of the CGIAR Trust Fund, complemented in some cases by Window 3 and bilateral funding.

In this way, CGIAR can quickly leverage its activities and assets to help countries cope with the effects of the pandemic. To enhance the COVID-19 orientation of its 2020–2021 portfolio, CGIAR is already mobilizing use of its existing models, tools and solutions. For example, CGIAR is deploying economic models to assess the impacts of COVID-19 on poverty and food security, livestock data analytics to support development of a COVID-19 vaccine and a range of work to assess the risks and benefits of wet markets, to strengthen food system resilience and to expand the effectiveness of nutrition programs and interventions during the pandemic (additional examples are listed in Appendix 3).

In practical terms, to meet the new urgent needs of CGIAR stakeholders, each CRP is balancing its agenda between delivering on the research as established in its plan of work and budget for 2020–2021 and, where activities cannot take place due to lockdowns and travel disruptions, using the newly freed-up resources to pivot work to COVID-19 responses.

Within **food systems**, such adaptable research includes collecting real-time information on the impacts of COVID-19 on food production (e.g. crop livestock and fisheries), on marketing systems and on households. It includes identifying, generating and deploying interventions (e.g. technological market and institutional) such as seed systems to build resilience and enhance farm income and food supplies. For example, in response to COVID-19, CGIAR is supporting Bangladesh, Egypt, India, Myanmar, Nigeria and Timor-Leste in tracking the availability and price of aquatic foods and the inputs needed for aquatic food production. To improve food system resilience and to reduce the need for humanitarian aid, CGIAR has also started working closely with WFP and other partners to improve access by vulnerable populations to nutritious food (Appendix 3).

As part of **One Health**, CGIAR pivots include providing a network of COVID-19 vaccine researchers with ILRI's excess high-performance computing capacity, assessing the risks and benefits of wet markets and other informal value chains, rationalizing antibiotic use to reduce development of antimicrobial resistance (AMR) and working with Kenya's Ministry of Health to identify laboratory facilities for SARS-CoV-2 screening (Appendix 4).

CGIAR research supports **inclusive public programs** by employing existing tools to guide programs aimed at protecting women's income and livelihoods in aquatic and other food value chains. Other CGIAR work is assessing the potential of irrigation and domestic water services to facilitate handwashing and other important water uses near homesteads (Appendix 3).

CGIAR **policies and investments** work includes running IFPRI's global and regional models to determine the poverty impacts of interacting and compounding shocks of COVID-19 and to predict production shortfalls by mapping recent crop production. Complementing this work are "deep dives" with country-specific COVID-19 impact modeling, analyses to help governments reassess their policy priorities under COVID-19 and compilations of national COVID-19 policy databases (Appendix 3).

c) Scaling up research for short-term response, medium-term recovery and long-term resilience

Key messages:

- The global response to the pandemic must be swift and science-based, harnessing new and existing knowledge. In close collaboration with its partners, CGIAR is ready to provide immediate response and assistance for those most in need, ongoing and inclusive support in **recovery** and, perhaps most importantly, future **resilience** to all shocks—including climate extremes.
- Building and expanding on the research capabilities of CGIAR, new evidence and tools to prevent and respond both to emerging disease threats and to comparable food system shocks can be generated in the short to medium terms.
- The crisis has demonstrated how vulnerable health and socioeconomic systems are, but also that collective positive change in human behavior is possible at scale and speed.
- The COVID-19 crisis presents an unprecedented opportunity for humanity to **"build back better,"** particularly in the food systems that lie at the root of this and other zoonotic pandemics. CGIAR will join its network of partners to help determine what "building back better" looks like for food, land and water systems.

Table 1 outlines CGIAR research responses in the short, medium and long terms for each pillar presented in Section 4, Part (a), above. Clear distinctions are made regarding what CGIAR will achieve across the relevant research themes to support countries at different stages of their epidemiological curves. These will be used to coordinate actions across the CGIAR System, to identify gaps and to communicate the research offer and its value-addition to governments and development partners.

Table 1: CGIAR research responses to COVID-19 in the short, medium and long terms.

	Short term: Crisis Response Up to 12 months[5] Provide immediate evidence and tools for decision-making to support food availability and access, health interventions and public programs, policies and investments at scale.	**Medium-term: Recovery** Up to 18 months Understand the impacts of crisis response and adapt policies and programs to reflect initial experiences and consequences for all groups in society. Recovery actions consider longer-term resilience issues.	**Long-term: Resilience[6]** Up to 24 months and beyond Generate evidence and tools to prevent and manage emerging disease threats and comparable food system shocks and build greater resilience into food, land and water systems.
Food systems	Support production of adequate and diverse foods; monitor supply and accessibility of vital agricultural inputs; provide options for supply chains and markets for both staples and perishable foods in different contexts; monitor and propose measures to reduce market volatility and enhance access to food among vulnerable groups.	Adapt systems for food supply and access; use digital technologies to monitor, predict and adapt food flows; assess the adaptive capacity of food systems; analyze COVID-19 impacts on household livelihoods and assets, labor supply and gender and equity issues.	Generate evidence to build back better and make food, land and water systems more robust and resilient to shocks and disruptions; adapt systematic approaches to food system transformation that link health, sustainability and socioeconomic outcomes.
One Health	Provide evidence and information on disease risks from an integrated human-animal-environment health perspective; maintain key food safety and One Health programs; ensure that disease control strategies help rather than harm poor people and women.	Strengthen risk-based food safety approaches appropriate for informal marketplaces where the poor buy and sell their food; develop One Health and risk-based approaches for key public health risks associated with agriculture-environment management and emerging zoonoses and agriculture-associated antimicrobial resistance.	Implement practices for better managing the agriculture-environment interface (including aquatic systems and forests) to reduce the risk of the emergence and spread of zoonotic diseases and to improve rapid detection and response to emerging disease.
Inclusive public programs	Identify the food, nutrition and related livelihood needs of key vulnerable groups and devise and implement programs that provide appropriate and timely resources.	Assess the benefits and costs of public programs and develop interventions to improve food and nutrition security by supporting the prioritization of programs where fiscal capacity is constrained.	Develop and implement longer-term strategies for fragile areas and vulnerable populations that effectively integrate development and humanitarian programs to improve food system resilience.
Policies and investments	Conduct global and regional scenario analyses to determine COVID-19 impacts on food, nutrition and livelihood security and inform COVID-19 policy responses needing to balance different government priorities.	Guide the adaptation of crisis policies and investments to reflect lessons learned in mitigating the pandemic's health and economic impacts on food and nutrition security; consider differential actions in key sub-national regions.	Support more effective cross-sectoral policies and investments for food system resilience and One Health preparedness that link environment, economic, social and health outcomes.

[5] Different timeframes will apply to different countries as they move through the COVID-19 epidemiology curve.
[6] Based on the existing portfolio. After 24 months, the long-term response will form part of the CGIAR Research Strategy 2022–2030.

In the **short term (up to 12 months)**, CGIAR research supports crisis **responses** with evidence and tools for immediate decision-making and actions in support of food availability and access, public health and related enabling public programs, policies and investments made at scale. CGIAR's high-frequency, on-the-ground monitoring data and scientific evidence will help policymakers and implementers assess their varied levels of preparedness and resilience in terms of food and livelihood security. Appendix 4 provides examples of research outputs by pillar

Initial CGIAR responses will use existing economic models to run global and regional scenario analyses to understand COVID-19 impacts on economies, livelihoods and food security. The results will inform policy responses and measures to reduce market volatility, help ensure sufficient and diverse food supply and identify the needs of key vulnerable groups. The responses will also supply decision makers with evidence on zoonotic disease risks obtained using integrated human-animal-environment health approaches.

In the **medium term (up to 18 months)**, CGIAR work will focus on crisis **recovery** by refining understanding of the impacts and trade-offs of various responses made to the pandemic and by helping governments and organizations to adapt policies and programs using this learning. Additional analyses of COVID-19 impacts on household livelihoods and assets, labor supply and gender and equity issues will disclose further lessons for mitigating health and economic harms. Advanced digital technologies used to monitor, predict and adapt food flows will be part of this work (Appendix 4).

CGIAR's medium-term work includes research innovations to ensure that throughout the pandemic and its aftermath, rural and urban populations have access to sufficient, safe and nutritious food. CGIAR will also help nations develop broad One Health and risk-based approaches to better managing key public health risks associated with (i) agriculture-environment management and emerging zoonoses and (ii) agriculture-associated antimicrobial resistance. Research in this period will also determine and prioritize gender-sensitive and socially inclusive actions that enhance food and nutrition security at all levels, from household to global (Appendix 4).

In the **long term (up to 24 months and beyond)**, CGIAR will generate evidence and tools to prevent and respond to emerging disease threats and comparable food system shocks and build greater **resilience** in food, land and water systems, which includes developing One Health approaches. An aim to **"build back better"** – and not to return to business as usual – following the COVID-19 crisis is a priority for One CGIAR.

Developing robust food systems that are resilient to shocks and disruptions requires good management of the agricultural and aquatic systems and environments, including forests, at their interface. This management reduces the risk of zoonotic diseases emerging and spreading. Longer-term strategies that integrate development and humanitarian programs are needed in fragile areas and by vulnerable populations. Research is also needed to support effective cross-sectoral policies and investments linking beneficial environment, economic, social and health outcomes.

To rebuild ecosystems and reverse agroecosystem declines in order to reduce the risk of future zoonotic and other environmentally driven human crises, CGIAR will conduct assessments and interventions to build agricultural, environmental and community resilience. To prevent future zoonotic outbreaks from becoming epidemics or pandemics, CGIAR will work with partners using a One Health perspective. More specifically, CGIAR will utilize its capabilities to determine how to better assess infectious disease risks in food systems, how to anticipate transboundary disease outbreaks and how to ensure a more universal preparedness (e.g. in water supply). This work includes improving overall disease surveillance in health, phytosanitary and food systems, both to prevent disease outbreaks and to respond rapidly to outbreaks that do occur (Appendix 4).

"Building back better" also means accounting for the impact of intensive farming on the environment and building ecosystem health by reducing the footprint of agricultural systems and restoring degraded landscapes to protect biodiversity and safeguard animal, human and environment health alike (Appendix 4).

Lessons learned and results obtained from adapting and scaling up research conducted in 2020–2021 will inform development of the CGIAR Research Strategy 2022–2030 and the research program for 2022–2024, thereby constituting a long-term strategic response to the "new normal" brought by COVID-19.

d) Mechanism for coordinating CGIAR's research response to COVID-19

Key messages:

- CGIAR aims to establish a **"CGIAR COVID-19 Hub"** for the coordination, across CGIAR and key partners, of major streams of relevant research, engagement and communications. The CGIAR COVID-19 Hub will be run in partnership with LSHTM.
- This mechanism will ensure that **relevant research results are drawn from across the system and are made accessible**, in appropriate formats and through effective channels of communication, to key decision makers and stakeholders in the agricultural sector. This will maximize uptake of CGIAR innovations by countries most vulnerable to the many societal costs the pandemic is causing.
- The CGIAR COVID-19 Hub will provide high-level coordination and **a "one-stop shop" for CGIAR funders and major partners** seeking to engage with CGIAR on COVID-19 research and responses.
- To provide swift support to global and country efforts during crisis response and recovery, the CGIAR COVID-19 Hub will invest its efforts in the highest-priority areas where research results and enhanced coordination are most critical, including **surveillance and modelling.**
- The CGIAR COVID-19 Hub will promote a **system-wide strategic research response**, drawing from expertise across the system for a multidisciplinary response.

A set of strategic opportunities for CGIAR to scale up research with the greatest relevance for COVID-19 stand out. The first is **enhanced surveillance and assessment of food availability and access in key markets and by different population groups**. This work will provide a reliable and detailed picture of the adverse impacts of COVID-19 on poor people and the best ways to address these. Other critical areas for near-term attention are **management of zoonotic disease risks** and scenario analyses on epidemiology, poverty and food security to support national and global policy. These research areas correspond to CGIAR responses to COVID-19 in the short and medium terms.

For the new CGIAR COVID-19 Hub, CGIAR proposes the same timeframe as that of the current business plan, which extends to the end of 2021. The proposed CGIAR COVID-19 Hub will be managed under A4NH and housed under its Flagship 5 "Improving Human Health". Flagship 5 is co-implemented by IFPRI, ILRI and LSHTM and has the advantage of already housing the CGIAR AMR Hub. To augment current A4NH management, CGIAR will add one leader of a CRP with substantial COVID-19 research activities and a CGIAR System Organization staff member to the CGIAR COVID-19 Hub management team, consisting of the A4NH director and representatives from ILRI and LSHTM.

The CGIAR COVID-19 Hub will provide high-level coordination and a "one-stop shop" for CGIAR funders and major partners seeking to engage with CGIAR on COVID-19 research and responses. CGIAR has large and long-established capacity for research on: (i) Food systems, on both the demand and supply sides; (ii) One Health research into such increasingly important aspects as food safety and zoonotic diseases; (iii) Economic, gender and equity assessments of public

programs and (iv) Deep insights into food policy and investments in LMICs. CGIAR will make this capacity available to funders and international and national partners through its research, convening and communications work. Given the importance of agriculture and food to the economies and livelihoods of LMICs, we see a particular role in reaching out to cross-sectoral development partners, including those in the health and humanitarian sectors.

The CGIAR COVID-19 Hub will promote a system-wide strategic research response to the pandemic by partnering with skilled personnel across CGIAR Research Centers on common COVID-19 research topics and cross-Center in-country responses. The CGIAR COVID-19 Hub will not seek to comprehensively lead or coordinate all COVID-19 research by all CGIAR CRPs and CGIAR Research Centers. Rather, it will invest its efforts in the highest priority areas where coordination is most critical, such as in surveillance and modeling, to avoid duplication of research efforts and engagements with partners. The CGIAR COVID-19 Hub will not divert Window 1 funds from the CGIAR Research Portfolio but will be able to accept and distribute new Window 2 and other research funds that may emerge in response to the COVID-19 crisis. This mechanism will ensure that relevant research results are drawn from across the system and are synthesized and made accessible, in appropriate formats and through effective communication channels, to key decision makers and stakeholders in the agricultural sector.

Operations of the CGIAR COVID-19 Hub will depend on levels of funding. Three possible scenarios are:

1. Minimal additional funding (<USD 1 million) will support a few common research projects, largely adapted from existing research, along with cross-CGIAR coordination and research partnerships with national institutions in a few countries (e.g. the CGIAR partnerships cited above in Bangladesh and Ethiopia).

2. Modest additional funding (USD 1–10 million) will support important facilitations of new research for country-specific actions and decisions linked to demands from national partners; the modeling of key national and regional trends; and surveillance of impacts on key sub-populations of women, children and poor communities. Depending on the level of funding, some cross-CGIAR coordinated actions linked to country demand in the recovery phase can be developed.

3. Substantial additional funding (>USD 10 million) will support comprehensive new response and recovery research with clear bridging to CGIAR research beyond 2021. Major support would be provided to partner countries through cross-CGIAR coordinated actions linked to country demand. Joint work would be conducted with the health sector on co-managing health, food and economic actions and consequences. Further expansion of cross-CGIAR coordinated actions would be linked to country demand in the recovery phase.

5. HOW we work with others

a) Partnerships for impact

Key messages:

- The global community, including CGIAR, has rapidly responded to the COVID-19 crisis by utilizing existing partnerships and forming new ones with NARES, government departments, NGOs, UN agencies and the private sector.
- By assessing the work of other organizations, CGIAR can identify suitable partners, position its research and prioritize initiatives where its value-added can most effectively contribute in responding to COVID-19.

The global community has come together in response to the COVID-19 crisis. Although many people are working from home, CGIAR partner organizations have risen to the challenge and have initiated a wealth of ideas, actions and programs to counter the massive societal disruptions caused by COVID-19. CGIAR is strengthening these partnerships and developing innovative partnership arrangements, leveraging COVID-19-relevant expertise, shared resources and networks. As well as partnering at the country and regional level with NARES, government departments, NGOs and the private sector, CGIAR works closely with the three Rome-based UN agencies (i.e. the Food and Agriculture Organization of the United Nations (FAO), IFAD, and WFP), which offer premier development, humanitarian and resilience support for global food, agriculture and rural development. See Boxes 3 and 4 for indicative examples of recent partnerships.

Box 3: CGIAR One Health approach to controlling zoonotic diseases in low- and middle-income countries: Engagement with the tripartite organizations—FAO, World Organisation for Animal Health (OIE) and WHO

Zoonotic diseases like COVID-19 that can spread between animals and people continue to have major impacts on human health. As the current crisis has laid bare, diseases know no borders and zoonotic diseases are increasingly posing problems worldwide. To meet this and similar global health threats, collaboration, coordination, communication and concerted action are all needed among experts in very different sectors—with all of them using a multi-sectoral, One Health approach to problem-solving. Many countries, however, lack capacity to implement such collaboration.

CGIAR's engagement with the tripartite organizations (i.e. FAO, OIE, WHO) provides evidence and expertise to address a range of emerging infectious diseases under a One Health approach. CGIAR is working with the WHO, for example, to control sleeping sickness, a re-emerging disease with a zoonotic interface and to develop a policy brief and background paper on food safety, which will include spillovers of diseases in food value chains. CGIAR is also member of the WHO Roadmap for Rift Valley Fever Taskforce (Rift Valley fever is another emerging infectious zoonotic disease).

CGIAR also collaborates with the OIE in a public-private partnership delivering animal health services, including better surveillance of emerging and epidemic diseases. CGIAR led a technical item in 2019 and is editing a volume in the 2021 OIE Scientific and Technical Review. Both OIE and CGIAR focus on external factors that affect veterinary services, especially emerging zoonotic disease outbreaks and their potential epidemics and pandemics. CGIAR is also working to prioritize vaccines for animal diseases and is conducting a feasibility study for de-risking livestock trade across the Red Sea.

CGIAR is currently working with FAO on food safety issues with a focus on the ubiquitous wet markets of developing countries. CGIAR has worked with FAO in the past on control of important zoonotic diseases, including highly pathogenic avian influenza and Rift Valley fever.

Box 4: Working closely with national partners on rapid economy-wide analysis in response to COVID-19

Following the rapid spread of COVID-19 and rollouts of national policy responses to contain the viral transmission, CGIAR partners in numerous countries requested assessments of the expected impacts on critical economic sectors, agri-food system performance and key development

outcomes such as poverty and food insecurity. CGIAR is working closely with those partners, primarily government ministries and agencies, to ensure that these analyses feed into policy.

In Rwanda, for example, CGIAR researchers worked with the Ministry of Finance and Economic Planning and the Ministry of Agriculture and Animal Resources to assess the short- and medium-term economic impacts of the COVID-19 outbreak and lockdown policies on various sectors. Their preliminary estimates indicate that Rwanda's GDP could decrease by 39% during the 6-week lockdown when compared to the projected no-COVID situation, with the agri-food sector experiencing a 16% decrease even despite policy efforts to insulate the country's farmers, traders and processors. These and other results were presented to the government and development partners and various recovery scenarios were discussed.

In the case of Nigeria, while food production and marketing activities are similarly exempted from most national COVID-19 restrictions, results showed that they are still affected by falling consumer incomes and other shocks, leading to an 18% decrease in agri-food GDP during the lockdown period. While national poverty also increased by 15% during this period, the analysis finds that poverty impacts will stabilize by the end of 2020 as people return to work, incomes recover and demand resumes. This analysis was conducted in close collaboration with the Central Bank of Nigeria.

CGIAR is similarly working closely with partners in Egypt, Ethiopia, Ghana, Indonesia, Malawi, Myanmar, Nigeria, Pakistan, South Africa and other countries to provide rapid policy analysis in response to COVID-19.

Summary of Selected Strategic Responses to COVID-19

Type of organization	Strategic responses
UN agencies and intergovernmental organizations	■ Launching funds and channeling some resources to WHO ■ Fast-tracking funding to countries and implementers ■ Providing humanitarian response plans and coordination ■ Providing emergency food aid and redesigning delivery mechanisms ■ Using tools and research to understand impacts on food systems, including on women and vulnerable groups ■ Mobilizing working groups to generate and share knowledge about implications of COVID-19 for animal health and veterinary public health
International NGOs	■ Working in countries to address immediate health and sanitary needs ■ Communicating accurate information to service providers and the public ■ Focusing on vulnerable groups, especially women and children ■ Making calls to address disease links to the environment and wildlife
Development partners	■ Rerouting funding to COVID-19 efforts and providing new funds towards vaccine development, public health support and detection, isolation and testing ■ Rolling out innovative budget adjustment processes and providing flexibility to implementers on projects affected by COVID-19 ■ Coordinating responses on needs regarding research and evidence
Regional institutions and national partners	■ Adopting a regional approach to combating COVID-19 and coordinating national responses ■ Contributing to emergency funds and providing resources (e.g. test kits) to member states ■ Committing to keep borders open for food and agricultural trade
Private sector	■ Protecting workers and creating back-up plans to map operational risks ■ Ensuring vital supply chains remain alive, especially food supply chains and tree-based pulp and paper supply chains directly engaged in the fight against COVID-19 (e.g. personal protective equipment, masks, medical gear) and supporting supply chains through digital means ■ Increasing local sourcing of sustainably produced food and feed

Academia	■ Redirecting research efforts toward COVID-19-related issues ■ Researching vaccine development with public and private groups ■ Investigating transmission of infectious zoonotic diseases ■ Convening online meetings to discuss policy options to secure food supply chains, food production and protection for poor people ■ Initiating programs on links between environments, forests and disease dynamics

The above assessment facilitates **identifying** organizations that can maximize the reach and impact of CGIAR's work and **positioning** CGIAR to establish COVID-19 knowledge partnerships. It also guides **prioritization** of initiatives where CGIAR's "value-added" can contribute most to effective responses to COVID-19.

b) CGIAR capacities in responding to COVID-19

Key messages:

- Research-based knowledge and evidence is urgently needed to ensure that response efforts effectively mitigate the impacts of COVID-19, strengthen the world's food systems and prevent future zoonotic diseases.
- CGIAR brings significant value-addition by generating and sharing knowledge and data as public goods, by rapidly informing policy and programmatic responses, evaluating impacts, building capacity and leveraging its networks, especially in LMICs.

Because the COVID-19 crisis is exceptionally complex, with its direct and indirect impacts affecting all aspects of life in both developing and developed countries, virtually all international and national organizations understand that urgent action is needed. A flurry of initiatives and activities are being implemented in response to the pandemic. This hurried activity only underscores the need for research-based knowledge and evidence to help ensure that these efforts manage to mitigate the adverse effects of the crisis, strengthen the resilience of the world's food systems and prevent future zoonotic diseases from emerging.

Given the principles of CGIAR engagement, our assessment of what others are doing and the demand articulated by partners, we see the following roles for CGIAR to play:

- **Generating and sharing knowledge**, data and evidence-based research as a public good
- **Closing critical gaps** in knowledge based on demand from decision makers and partners
- **Actively sharing existing knowledge and experience** harnessed to address the specific challenges that COVID-19 poses with governments, NGOs and private-sector companies looking to make beneficial changes in food systems
- **Rapidly informing policy and programmatic responses** using data, models and evidence and with a people-centered focus on gender, nutrition and livelihoods
- **Conducting impact evaluations** of global and national policies and programs
- **Building capacity** in LMICs to make best use of their agricultural research to provide timely, evidence-based responses to this and future crises
- **Leveraging networks** for research at global, regional and national levels and across disciplines, especially in LMICs
- **Forming strong strategic partnerships** that add value to networks and organizations
- **Communicating consistent messages** to national, regional and global leaders and establishing lines of communication to evaluate needs and share knowledge.

CGIAR will join hands with other organizations to maximize the reach and impact of its work, to avoid duplicative efforts and to support those initiatives where CGIAR can contribute most to effective responses to COVID-19.

APPENDIX 1:
COVID-19 research response in relation to CGIAR impact areas on nutrition and food security; poverty reduction, livelihoods and jobs; and gender equality, youth and social inclusion

a) Nutrition and food security

COVID-19 will have both direct and indirect impacts on nutrition and food security across the four research pillars. Poor and vulnerable segments of the population will be most affected.

Short-term nutrition considerations:

- COVID-19 and the restrictions implemented to reduce the spread of the virus are adversely affecting food security and nutrition across the word. Impacts may be quite different for those who produce part of the food they consume through family labor and limited imported inputs and those who rely on markets to satisfy their demand (especially in cities).

Medium- to long-term nutrition considerations:

- The roles of state and private actors in buffering food and nutrition impacts (e.g. via fisheries and aquaculture) in poor households, especially in urban areas.
- Governments will need to account for the broader impacts of COVID-19 on nutrition when developing both short- and long-term action plans in response.
- There has been global progress toward meeting nutrition goals in recent years and we must ensure that these are not reversed, particularly in sub-Saharan Africa.
- The potential for the landless and urban poor to turn to fisheries, forests and grasslands for food and income has to be considered. Strategies should allow that as a safety net but not overwhelm those who have built longer-term livelihoods and institutions to manage access.

b) Poverty reduction, livelihoods and jobs

The economic impacts of COVID-19 underpin and amplify many of the other direct and indirect effects. For poor people, especially, it is almost impossible to distinguish income shocks from food and health shocks. The direct and indirect shocks of COVID-19 will likely compound other vulnerabilities and inequities (e.g. impacting women's well-being, employment, labor and risk profile).

Short-term poverty and equity considerations:

- Many poor people will be adversely affected by COVID-19 responses that constrain their ability to produce and harvest food (e.g. crops, livestock, fish) and reduce employment opportunities. This raises several research questions, including What kind of coping strategies will they adopt? How are affected households using their environment and other resources such as safety nets for food and other basic needs?

Medium- to long-term poverty and equity considerations:

- We must ensure that the poor are included in recovery efforts. Recovery is expected to be quite slow and poor countries may struggle to borrow due to their high debt burdens.

- The research questions that these considerations raise include the kind of adaptation strategies that the poor people adopt in the medium- to long-term and how integrated food systems could help strengthen their resilience.

c) Gender equality, youth and social inclusion

Past research and learning indicate that small adaptations that make program design and implementation more gender-sensitive may result in overall gains and progress for marginalized and vulnerable groups. Where possible, decisions around gender-sensitive design and implementation should be informed by rapid assessments from the outset, ideally building on gender analyses of existing schemes. Because the impacts of COVID-19 on gender-related outcomes are expected to continue over the long term, social protection programs addressing gender issues should be conducted beyond the short term, with greater gender equality leading to better and healthier food systems that serve the needs and priorities of all.

Short-term gender considerations:

- We need to understand: (i) Whether COVID-19 information reaches women, given that many in-person communication channels have been shut down; (ii) Whether women's typical roles (e.g. collecting fuel, water) are now supported through government or civil society programs and (iii) The short-term impacts of COVID-19 on men's and women's livelihoods and assets.
- Adapting existing public programs to be contagion-safe is a likely first step for governments and implementers. Modifications made to continue providing benefits to people, to remove barriers to accessing and enrolling in safety net programs and to make these programs unconditional (automatic) will benefit women whose mobility may be constrained or may have fewer social and information networks. The modalities by which these schemes are implemented also have significant gendered implications that should be considered.
- During times of food insecurity, women and children may be the first to reduce their food consumption due to intra-household inequalities. Providing direct cash transfers, in-kind transfers or food vouchers can improve food security for all household members. However, because food insecurity caused by COVID-19 is different from that caused by other factors (e.g. lack of productive resources, drought or civil unrest), the intra-household effects of the pandemic are not yet fully understood.
- Ongoing research in a variety of contexts can be used to think about how nutrition- and gender-sensitive agricultural programs can work to improve a variety of outcomes such as health, nutrition and resilience, which may mediate the effects of COVID-19.
- The approaches used for COVID-19 gender research are often based on extrapolation from past crises. We urgently need more data to investigate the short- and longer term impacts of the pandemic and to shift the focus of agricultural research to account for the social context that has changed because of COVID-19.

Medium- to long-term gender considerations:

- Research should assess whether social protection and gender-sensitive agricultural programs were protective against the ill-effects of COVID-19.
- If public works are implemented as social distancing restrictions are relaxed, the implementers should ensure that women's wages are fair, the work has dignity and it is safe for women to participate, taking into consideration the needs of lactating and pregnant women.

- When schools reopen, governments should take steps to relax school fees where possible through, for example, universal fee waivers and cash transfers for education, particularly for adolescent girls who may be at heightened risk of dropping out of school.
- During rebuilding, programs should work to ensure that women's assets, which are often forfeited to meet short-term needs, can be rebuilt.

APPENDIX 2:
CGIAR Research Portfolio 2020–2021 relevant to COVID-19 response

Examples of research results generated as part of the current CGIAR portfolio that are relevant to COVID-19 include:

a) Food systems

As an immediate priority in this pillar, during the COVID-19 pandemic and its aftermath CGIAR continues to contribute to ensuring sufficient and diverse ***food production***. Agricultural technologies and tools that increase the efficiency of input use and are appropriate to various groups of farmers are at the forefront of the emergency response. The CGIAR Research Program on Fish (FISH); the CGIAR Research Program on Grain Legumes and Dryland Cereals (GLDC); the CGIAR Research Program on Livestock (LIVESTOCK); the CGIAR Research Program on Maize (MAIZE); the CGIAR Research Program on Rice (RICE); the CGIAR Research Program on Roots, Tubers and Bananas (RTB) and the CGIAR Research Program on Wheat (WHEAT) are delivering essential innovations to boost, diversify and sustain production of crops and animal products, improving the productivity, resilience and nutritional value of crops and animal products. MAIZE and WHEAT apply diverse tools (e.g. crop modeling, geographic information systems, economic foresight modeling) to explore the effects of COVID-19 on crop production.

Reduced supply of inputs is a major threat to agricultural productivity during the crisis. Seed distribution, as the starting point for food production, has a prominent place in CGIAR research as part of multiple crop-related CRPs.

Current research includes seed-related technologies, approaches, policies and regulations to ensure farmers have timely and good-quality planting material. Examples of this work include:

- RICE is accelerating work to modernize its rice breeding programs to develop and deliver improved rice germplasm to partners and farmers more efficiently and effectively.
- RTB is working with partners to use advanced information and communications tools, rapid propagation methods and other technologies to boost the efficiency of seed systems and to speed up delivery and use of improved varieties of roots, tubers and bananas.
- GLDC is commercializing legume and dryland cereal cultivars with increased grain yield and is enhancing adoption of the new improved cultivars to increase production in Africa and Asia.
- GLDC; LIVESTOCK; CGIAR Research Program on Policies, Institutions and Markets (PIM); RICE and RTB have completed analyses to enhance gender-responsive seed systems and many are involved in the Gender and Breeding community of practice.

Crop-focused CRPs such as GLDC, MAIZE, RICE, RTB and WHEAT respond to pest/disease threats which, together with reduced access to seeds, extension services and finance due to the COVID-19 pandemic, could have devastating effects on productivity and food supplies. CGIAR experience with providing technical solutions, developing local capacities and coordinating rapid responses against devastating transboundary diseases and insect pests, such as maize lethal necrosis in Africa, fall armyworm in Africa and Asia, Ug99 and wheat blast, provides valuable lessons that can be applied in the current crisis.

CGIAR is working with partners to maintain a focus on nutrition-sensitive production and adequate supplies of food. Work by FISH and LIVESTOCK, for example, is helping to ensure highly nutritious foods for the challenged production systems of the poor. During 2020, an early release of improved carp species (rohu and silver carp) is planned for Bangladesh (subject to COVID-19 restrictions) to give smallholders and SMEs access to better and faster growing fish strains.

Ongoing joint research by FISH, RICE and the CGIAR Research Program on Water, Land and Ecosystems (WLE) in South Asia, Latin America and Africa has demonstrated the value of multidisciplinary approaches for enhancing resilience of food systems to multiple shocks. FISH conducts research to improve the resilience of small-scale fisheries and their safety net functions in terms of nutrition, employment and income. In times of shock such as COVID-19, for example, wild fisheries can provide an accessible source of nutrient-rich food, often distributed through informal value chains. Crops genetically adapted to tolerate heat and water deficits and to mature early by GLDC as well as other CRPs help boost resilience.

As demonstrated in the COVID-19 crisis, resilient food systems also depend on systematic approaches to food system transformation that link health, sustainability and socioeconomic outcomes (e.g. equitable income and inclusion). This is the focus of the 'food systems for healthier diets' program in A4NH and its focus on providing food system tools and approaches with national partners through its Food Systems Resource Center.

Most CRPs are testing innovations to reduce pre- and post-harvest losses at the farm and other stages in the value chain. PIM is collaborating with A4NH, FISH, MAIZE, WHEAT and RTB to test interventions in the value chain that will enhance food quality, efficiency and inclusion.

All CRPs collaborate with implementation partners to test approaches that will enhance uptake of their agricultural and food system innovations by farmers or other actors such as extension agents. This includes ICT tools, cost-effective capacity building approaches and the use of incentive mechanisms.

The work of CGIAR Research Centers undertaken with bilateral funding complements the research conducted by CRPs. For example, IFPRI monitors price and market conditions for food commodities on a global basis through its Food Security Portal. Through private-sector partners, ILRI is scaling out delivery of more productive and adapted poultry breeds to small-scale African producers to improve the supply of eggs and poultry meat. In Kenya, the International Potato Center (CIP) is working with WFP and local government authorities to safeguard farmer access to seed of potato and sweet potato for the coming agricultural season, linking agricultural extension services to seed suppliers in strategic locations accessible under COVID-19 restrictions. The Alliance of Bioversity and CIAT distributed 4.5 metric tons of improved, nutritious varieties of beans, rice and maize to 25 cities in 16 departments (half of all departments) in Colombia in response to the COVID-19 crisis.

b) One Health

Of particular relevance to COVID-19, Flagship 5 "Improving Human Health" in A4NH brings together animal health and public health communities to address One Health challenges. Other relevant work is occuring under the One Health regional network for the Horn of Africa and ILRI's new One Health Research, Education and Outreach Centre for Africa, including disease preparedness and analysis and capacity building.

Good ***human health*** helps people to fight off COVID-19 and a balanced, vitamin-rich diet is a key to achieving this health. Many RTB varieties have been produced with high vitamin,

iron and zinc content by breeding them for biofortification and screening existing landraces for more nutritious varieties. Biofortification is also an important activity under GLDC, which has delivered sorghum, pearl millet and lentil cultivars with grain with enhanced iron and zinc content and soybean cultivars with improved protein content. MAIZE has developed Vitamin-A- and zinc-enriched maize varieties. WHEAT has developed and released varieties with increased zinc in Afghanistan, Bangladesh, India and Pakistan. FISH and LIVESTOCK are both working to ensure greater availability of animal-source foods (e.g. milk, meat, eggs, fish), which are naturally nutrient dense and contain many vitamins and minerals at high concentrations.

During the pandemic, there is increasing demand for safe, processed foods that can be easily stored and marketed to reach large numbers of rural and urban poor through general markets as well as in food distribution programs. Maize, rice and wheat are staples suitable for long-term storage and can be processed easily. Supported by CRPs, CIP has started work with commercial food processors in Africa to produce shelf-stable (i.e. non-refrigerated) nutritious puree of biofortified sweetpotato produced by smallholder farmers.

Focusing on consumers, A4NH is developing and testing retailer and consumer-oriented interventions to improve fruit and vegetable intakes in key countries, particularly urban and peri-urban areas in Nigeria and Vietnam. To understand consumer behavior, the Alliance of Bioversity International and CIAT adapted a free Wi-Fi-based tracking program to ask traders and consumers logging onto the network questions about COVID-19 effects on food shopping habits in the wet markets of Vietnam. The answers are enabling CGIAR to observe, in real time, impacts of the pandemic on consumers.

A4NH is also conducting six, large food safety projects on informal value chains (e.g. milk in Kenya, chicken in Ethiopia, vegetables in Burkina Faso, meat in Uganda, pork and dairy in India, meat in Cambodia and pork in Vietnam). Project staff are already conducting surveys with participating farmers and customers on COVID-19-related knowledge, attitudes, practices and impacts. PIM and FISH are working to improve the safety of fish in Nigeria and PIM the safety of groundnuts in Senegal.

While ***animal health*** research comprises a smaller component of the CGIAR portfolio than crop health, it is well represented in LIVESTOCK and A4NH. Much of LIVESTOCK health research is relevant to the COVID-19 agenda. Both A4NH and LIVESTOCK are working to improve the safe consumption of meat, milk and eggs. Examples from the 2020 Plan of Work and Budget include the following.

- LIVESTOCK is developing and applying tools to assess the significance of animal pathogens and commensals and the risk of their emergence, as well as diagnostics and vaccines to improve their control. Understanding the prevalence and transmission of animal pathogens is key to prioritizing, targeting and implementing disease control through diagnostics and vaccines. This research should help prevent the emergence of new pathogens in animals and to improve our capacity to respond to those that do emerge. In 2020, these tools are being applied to the epidemiology and risk of infectious disease in small ruminants in several African countries to produce maps of tick distributions in North and East Africa and work on Crimean Congo hemorrhagic fever in camels, tick borne encephalitis and toxoplasmosis in sheep. The vaccine work is targeting contagious bovine pleuropneumonia, African swine fever and East Coast fever.
- LIVESTOCK is introducing and strengthening biosecurity both on the farm and at the market as part of its agenda to transform value chains for selected livestock products in four countries: Ethiopia, Tanzania, Uganda and Vietnam.

- Additional A4NH research on disease surveillance and risk-factor epidemiology focuses on the human-animal interface in Kenya.

Environment health, which is an integral part of One Health, is a major part of CRP milestones. CGIAR work in this area has helped communities and local governments to respond appropriately to the COVID-19 pandemic as well as to other natural hazards such as floods and droughts. And the development by WLE and CCAFS of bundled approaches for managing flood risk by monitoring and providing appropriate seeds and insurance has generated learnings that are now proving useful for managing health crises such as COVID-19.

A4NH; CCAFS; FISH; CGIAR Research Program on Forests, Trees and Agroforestry (FTA); LIVESTOCK; and WLE have produced important outputs for improving the health of environments and the resilience of smallholder agroecosystems and communities, which are important both for weathering shocks and for addressing the root causes of the COVID-19 pandemic. PIM works with several CGIAR Research Centers, FTA and WLE on research to strengthen the land tenure of smallholder farmers.

CCAFS delivers work on crisis resilience of the economy through regional crisis management. The impacts of COVID-19 on food systems in the Southern African Development Community were analyzed with virtual scenarios and response planning to help communities recover more quickly and be better prepared for future shocks. FTA conducts remote sensing work to collect data for large-scale mapping of environment health and to better understand the links between environment health and the emergence of infectious disease. A4NH is researching how irrigation schemes in the arid lands of Kenya are leading to outbreaks of vector-borne diseases and how interactions between livestock and wildlife around Kenya's national parks are transmitting disease.

c) Inclusive public programs

Inclusive public programs are essential for preventing people from falling into poverty and malnutrition due to the COVID-19 crisis. PIM has been investigating the effects of ***social protection*** programs in regions experiencing conflict and other shocks. Much has been learned about safety net programs and humanitarian relief efforts that can inform immediate responses to COVID-19. A4NH produces national food systems reports (with most data from Bangladesh, Ethiopia, Nigeria and Vietnam), which map local food systems, highlight areas of vulnerability and point to the coping mechanisms often embedded in informal and social structures.

Domestic markets and ***food distribution*** are also affected through shocks to urban food supply. Travel restrictions under COVID-19 have impacted cities, which depend on surrounding regions for key resources. WLE has been improving urban resilience to shocks affecting food supply through dialogues (e.g. in Cali, Colombia) to design food policies that can mend broken links between cities and their surrounding regions.

d) Policies and investments

CGIAR has strong competencies in economic analyses of ***pro-poor development strategies and investments and of national and regional responses to shocks***. These analyses include ex ante assessments of the impacts of food system shocks and of the scientific and social innovations made to withstand them. CGIAR's immediate analytical response to the COVID-19 crisis lies within these areas. PIM is improving its economic modeling and updating its datasets to assess the direct and indirect effects of COVID-19 now and over the short and medium terms globally and in about 20 countries. A4NH conducts participatory analyses of structural transformations of food systems in Bangladesh and Nigeria and its

multi-stakeholder platforms in Vietnam are making explicit how COVID-19 affects investment and policy options and how they are prioritized. Researchers need decision tools to help policymakers to assess, understand and anticipate food supply shocks caused by COVID-19 and to design appropriate policy responses. Such work is being done by WLE, which is monitoring harvests in South Asia to identify food supply shocks caused by COVID-19. PIM has tracked national policy responses to COVID-19 (e.g. policies regarding food trade and the informal food sector) and has already disseminated the results, which are being used in further analyses. FISH is providing evidence-based policy advice on management and governance for vulnerable populations in rice-dominated, multi-functional landscapes in the Mekong and the coastal fisheries of the Pacific.

APPENDIX 3:
Pivoting CGIAR research in response to COVID-19 during 2020–2021

The examples below describe some of the ways CGIAR is pivoting its current research portfolio to meet the challenges caused by the pandemic. CGIAR research in 2020–2021 will be pivoted in one of three ways: (i) By incorporating COVID-19 as an **analytic factor in existing lines of research;** (ii) By leveraging existing projects focused on **technology and institutional strengthening** in selected countries and regions and (iii) By **reallocating resources** that cannot now be deployed for field work and travel to COVID-19-related work.

Examples of (i) incorporating COVID-19 as an analytic factor in existing lines of research:

a) Food systems

- **Tracking COVID-19 impacts on fish market systems and community resilience (FISH)**. Quantitative tracking of the availability and price of aquatic food and the inputs for aquatic food production in response to COVID-19 is taking place in Bangladesh, Egypt, India (Andhra Pradesh, Assam, Odisha), Myanmar, Nigeria and Timor-Leste, targeting more than 100 actors in each country and in eight supply chain segments (i.e. feed mills, feed distributors, hatcheries, fish farms, fishers, processors, traders, retailers). Panel surveys are also being planned for fish-dependent coastal communities in selected Small Island Developing States to better understand community adaptation strategies and resilience under the COVID-19 shock. The data and evidence generated are being fed into policy guidance and shared via public, private and civil society partner networks. *(All food system themes)*
- **Determination of the most promising technologies and market/institutional interventions to build resilience and enhance farm income, with focus on vulnerable groups like rural women in Southern Africa and Western and Central Africa (GLDC)**. In 2020, GLDC will collect information on the impacts of COVID-19 on prices of farm outputs (e.g. grains, fodder, fruits, livestock, livestock products) as well as farm inputs and run modeling scenarios to identify various diversification and farming systems strategies that can help farm households to build resilience under such risky situations. *(All food system themes)*
- **Identification of practices that will enable smallholder farmers and other stakeholders in RTB production, processing and supply chains** to get back to work without exposure to COVID-19, ensuring human and food safety both. *(Markets and trade)*

b) One Health

- **Analysis of wet markets and other informal value chains (A4NH)**. For several years, A4NH has been developing approaches to de-risking wet markets to protect them against un-evidenced calls for bans. Ongoing food safety projects in informal value chains are already conducting surveys with participants, from farmers to customers, on COVID-19 knowledge, attitudes, practices and impacts. Situational analyses for the East African Community includes the risks and benefits of wet markets and the importance of an evidence- and risk-based approach to food safety. *(Human health)*

c) Inclusive public programs

- **Assessment of the role of multiple use water services in Mali (WLE).** WLE is assessing the potential of irrigation and domestic water services to jointly improve access to handwashing and other important household water uses near homesteads to address mobility and other COVID-19 related constraints. *(Inclusive responses)*
- **(Gendered) impacts on nutrition- and gender-sensitive agriculture programs (A4NH)**. The POSHAN program will expand monitoring and learning for nutrition-sensitive programs and interventions through its large partnership network and engagement with national and state governments in India. A4NH is also working with UNICEF and the West African Health Organization (WAHO) to help develop guidelines (e.g. to reduce wasting) and with FAO on how social protection programs within food systems can reduce health shocks such as the current pandemic. *(Inclusive public programs and support to national and regional responses)*

d) Policies and investments

- **Immediate impacts of COVID-19 responses on food and nutrition security (PIM and A4NH).** This work is combining global, regional and country model outputs in advice to governments on poverty, trade and food and nutrition security impacts in the crisis phase. These will be augmented by rapid surveillance of food and nutrition security impacts on vulnerable populations to inform and adjust immediate policy actions.

Examples of (ii) leveraging existing projects focused on technology and institutional strengthening in selected countries and regions:

a) Food systems

- **Investigation of viable seed supply models of GLDC crops and local food supply models (GLDC)** to sustain food production and access to food during and after COVID-19 *(Food production; Resilience)*
- **Digital community-based tools for bean value chains (GLDC)**. Strengthening and building resilience of rural-based SMEs (particularly women-owned) to continue providing services along the bean value chain during the COVID-19 pandemic and beyond. The challenges of getting supplies and access to markets while transport and other movement is restricted will be addressed by sourcing supplies and accessing markets through e-commerce supported by WhatsApp groups and other digital tools. *(Food production; Trade and markets; Resilience)*
- **Seed system interventions (RTB)**. Employing RTB diagnostic tools to understand local COVID-19 impacts and to identify seed system intervention points, including multi-stakeholder frameworks for analyzing seed security and seed network analysis. *(Food production)*
- **Assessment of the effects of COVID-19 on vegetable production and value chains in Ethiopia (PIM)**. Having implemented a survey of the value chain actors just before the COVID-19 outbreak, the assessment will include value chain disruptions, production shocks and input market disruptions as a consequence of COVID-19. *(Food production; Trade and markets)*

b) One Health

- **Impacts on antibiotic use and antimicrobial resistance (A4NH)**. The stress COVID-19 is putting on health systems may affect access to other kinds of healthcare, like treatments for bacterial infections, leading people to find new sources of antibiotics in both the medical and veterinary sectors, increased crossover and possibly greater risk of the development of antimicrobial resistance. Secondary bacterial infection is an issue in some COVID-19 pneumonias and antibiotics are being used (as well as investigated as primary therapeutics). The CGIAR AMR Hub is already working with Kenya's Ministry of Health to identify laboratory facilities for SARS-CoV-2 screening. *(One Health)*

c) Inclusive public programs

- **FISH gender integration guidelines** will be used to ensure that COVID-19-related adaptations (pivots) to flagship research use tools to identify the specific needs and experiences of women and men of diverse socioeconomic groups. These guidelines are made to guide government and private-sector responses and investments aimed at protecting women's income and livelihoods across all nodes of aquatic foods value chains. *(Inclusive response)*

d) Policies and investments

- **Ex ante analyses of the economic effects of COVID-19 (PIM)** using country multiplier models and detailed national accounts data in about 20 countries. *(Support to national and regional responses)*

Examples of (iii) reallocating resources that cannot now be deployed for field work and travel to COVID-19-related work:

a) Food systems

- **Testing integrated transformative intervention packages (LIVESTOCK)** using resources generated by delays and underspending in priority country field work in selected animal-source-food value chains offers an opportunity to adjust survey designs to collect information in real time about the impacts of COVID-19 on production and marketing systems and at the household level. *(all food system themes)*
- **Assessment of selected vegetable value chains in Ethiopia planned by the Ethiopia Strategic Support Program (PIM)**. The assessment will include value chain disruptions, production shocks and input market disruptions as a consequence of COVID-19. *(Food production; Trade and markets)*

b) One Health

- **Lending ILRI's high-performance computing capacity for COVID-19 vaccine development work (LIVESTOCK)**. Beginning 22 March 2020, ILRI has been donating half of its high-performance computing platform capacity to groups working to understand the folding of SARS-CoV-2 proteins at the Rosetta@home project as part of COVID-19 vaccine development. *(Animal health)*

Apart from pivoting Windows 1 and 2 parts of the portfolio, CGIAR Research Centers are responding to requests from some funders to undertake additional adaptive analysis, **by utilizing existing research capabilities and tools to quickly incorporate outbreak-specific work** in ongoing activities. For example, IFPRI is applying its global and regional models on

assessing the poverty impacts of the interacting and compounding shocks of COVID-19 and models to analyze possible production shortfalls based on mapping of recent crop production. It is also planning "deep dives" with country COVID-19 impact modeling, analyses to assist governments with reassessing policy priorities under COVID-19 and compilation of national COVID-19 policy databases. Moreover, food price and market condition monitoring of the IFPRI Food Security Portal is now using the data to assess COVID-19 current and future effects. IRRI is analyzing the channels through which the COVID-19 pandemic could affect the global rice sector and is developing a series of scenarios of these impacts. In Asia, IRRI engages with governments and national partners to collect information on the immediate and short-term effects of the COVID-19 crisis and its implications for rice-based food systems and provides policy support to prepare an adequate response.

To improve food system resilience and reduce need for humanitarian aid, CIP started working with WFP and other partners to improve the availability of, and access to, nutritious food among vulnerable populations in refugee and internally displaced person camps and regions affected by migration and insecurity. This includes linking cash transfer programs to increasing the availability of nutritious food in markets accessible to vulnerable populations and school feeding and distribution of food and seed through school structures while these might be closed for education during the pandemic. The Alliance of Bioversity International and CIAT has launched an initiative to document the effects of the COVID-19 pandemic on the production and consumption of rice in Latin America and the Caribbean. With its Rice Observatory, the Alliance will analyze the effects of the COVID-19 response implemented by Latin American and Caribbean countries on regional and global food systems. Moreover, in partnership with HarvestPlus, the Alliance of Bioversity and CIAT will redirect resources of the planting season to increase basic seed stock with high zinc and other lines with superior yield. Moreover, donations of rice grains for consumption by vulnerable rural communities will happen during the June and July harvesting season.

CIMMYT plans to use its Integrated Agri-Food Systems Initiatives, a strategic and tactical planning method that responds to real dynamics of complex systems, to guide adaptation of maize and wheat production systems to post-crisis realities. CIMMYT is participating in the design of the national response plans in Mexico and Colombia through private-sector and government response platforms using data from the bilateral and CRP investments to inform decision-making.

The International Water Management Institute (IWMI) is carrying out surveys to assess the impacts of water availability and access on virus exposure and on abilities to practice preventive measures in Ethiopia. Assessments are also carried out on how responses to the COVID-19 outbreak are affecting water use and wastewater management.

Some bilateral projects also include work on COVID-19 adaptation in livestock. For example, in East Africa, the African Dairy Genetic Gains project has established a phone-based messaging and data exchange service with over 30,000 dairy farmers. The system continues to operate while field activities with direct interaction with the farmers have been suspended under the COVID-19 measures. The project is using this mechanism to share information and messages about COVID-19 and adaptive management strategies. It may be possible to use this channel for reorienting activities to design and test specific advice on practices and impacts related to COVID-19.

APPENDIX 4:
Scaling up research for short-term response, medium-term recovery and long-term resilience

The examples below describe some of the ways CGIAR is scaling up its research for (i) short-term response, (ii) medium-term recovery and (iii) long-term resilience.

Examples of research that supports crisis response in the (i) short-term (up to 12 months):

a) Food systems

Food system surveillance to assess food availability and access in key markets (international and domestic, including urban and rural) of importance to vulnerable populations:

- Daily updating and enhanced country and food items coverage of domestic food price monitoring and enhancing tracking tools for trade restrictions and COVID-19 policy response and vulnerability.
- Analysis of updated data on changes in the prices of staple and non-staple foods during the COVID-19 crisis to examine effects on patterns of household consumption of various foods, dietary quality and malnutrition rates.
- Monitoring delayed crop planting and harvesting using satellite remote sensing. Seasonal forecasts from IBM are available and can be used to project potential production shocks.
- Using phone surveys to assess impacts on mobility, employment, income, time burden, water access, food security, dietary diversity and within family violence, among other factors, building on data sets from several countries (i.e. Bangladesh, Burkina Faso, Ethiopia, Ghana, India, Kenya, Nepal, Niger and Nigeria).
- State of production and harvest in major breadbaskets and/or in peri-urban food sheds around major cities (e.g. real-time monitoring of regional staple food production), specifically on seed sources, changes in the use of local versus commercial seed varieties and changes in production patterns.
- Monitoring markets and food consumption patterns before, during and after the COVID-19 crisis in specific geographies, such as the wet markets of Vietnam, corner stores (tiendas) in Colombia, Bangladesh fish markets and micro-supermarkets in Kenya.

b) One Health

The existing ***One Health*** capacities and tools can be applied to evidence and information on disease risks, for example:

- Investigating possible ongoing transmission of COVID-19 between animals and humans.
- Expanding testing for coronaviruses in food systems and wildlife to better understand viral evolution, transmission and reservoirs. For example, ILRI will use its laboratory facilities in Nairobi to support the Kenya government's ministry of health to test for SARS-CoV-2.
- Testing samples in repositories for coronaviruses and other potentially emerging pathogens.
- Supporting partners to upgrade laboratory biosecurity.

c) Policy and investments

Economic modeling using global and regional model-based scenario analysis including:

- Further global and regional policy scenario analysis to assess impacts on poverty and

food security of trade restrictions and staple food reserve build-up, alternative COVID-19 epidemiological scenarios, as well as multiple scenarios to identify needs for policy support to developing countries.

- Interacting and compounding shocks during the COVID-19 pandemic at the global level. Interacting shocks can include value and marketing chain disruptions, production shocks, demand-side disruptions and changes in GDP growth.

Examples of research that supports recovery in the (ii) medium-term (up to 18 months):

a) Food systems

- Fast-tracking technologies at scale for seed and planting material multiplication and networks for distribution, focusing on seed technologies for crops that can be adapted and mobilized to respond to the crisis.
- Research on urban agriculture to improve the availability of healthy products, closer to markets where the demand will increase. This requires different and innovative partnership arrangements and can be based on the experience that, for example, CIP had in leading the System-Wide Program on Urban and Peri-Urban Agriculture in the past.
- Scaling innovations with partners to increase job opportunities in rural and peri-urban areas. AfricaRice has already started developing projects where innovations such as RiceAdvice and GEM rice parboilers are adopted by service providers and small business groups. Such business models may involve relatively resource-rich actors in the rice value chain as resource lenders, including microfinance.
- Digitally enabled crop advisory services in use across CGIAR can be harnessed to connect to partners and millions of farmers for information dissemination, technical advice, information and market systems, etc. Examples that can be scaled up include providing farmers with real-time access to virtual extension services and information, through Ushauri, a fully scalable mobile platform tool (meaning "Advice" in Swahili) already tested in East Africa (Kenya and Tanzania) that matches agricultural extension services with farmers' knowledge needs.

b) One Health

- In Tanzania, it would be possible to leverage the "Women in Business" project to evaluate how the enhanced delivery of vaccine packages reduces occurrence of avian viral diseases that are also zoonotic, e.g. Newcastle disease, a minor zoonosis. In the same vein, this project could also be leveraged to explore the occurrence of the common avian infectious bronchitis virus (a non-zoonotic coronavirus) and its relationship to zoonotic SARS-CoV-2, in collaboration with interested laboratories, which could inform efforts to control SARS-CoV-2.
- The facilities and skills in the Biosciences eastern and central Africa-ILRI Hub (BecA-ILRI Hub) can be used to strengthen and build capacity of diagnostic and epidemiological services for reliable surveillance, disease confirmation and differential diagnosis of coronaviruses and COVID-19. The CGIAR AMR Hub could assess the role of AMR in pandemics, because AMR reduces effectiveness in preventing bacterial infections, either as primary or secondary infections, and more antimicrobials are used, promoting AMR.
- Using a One Health approach to identify risk factors for disease spread through different channels (e.g. wet markets, informal food trade); understanding spatial and other links between livestock, wildlife and environments; and developing and piloting better surveillance and response systems, including those used for MERS, a coronavirus similar to SARS-CoV-2.
- ILRI has established two initiatives: (i) A newly established One Health Research,

Education and Outreach Centre for Africa and (ii) A longer-term EcoHealth network with southeast Asian universities. These platforms are active in building multidisciplinary capacity–veterinary, medical, agronomic and environment–and they can be involved in helping to understand and manage COVID-19.

Examples of research that supports resilience in the (iii) long-term (24 months and beyond):

Integrated multidisciplinary research for "building back better":

- Safeguarding human health through better nutrition for adequate micro- and macronutrient intake. Tapping agriculture as a provider of nutrients and vitamins would have a far-reaching impact in addressing such diseases, particularly for communities and regions that depend on locally produced foods and where health systems are weak.
- Strengthening domestic food production with shorter food supply chains to mitigate the risks of market disruptions. This includes assessing the role and promotion of locally produced crops such as rice, maize, roots and tubers, vegetables and other short-cycle crops as a buffer to food crises generated by disruptions in the marketing of commodities traded internationally.
- Expanding One Health research on prevention and management of health by strengthening the role of environment research in One Health and assessing the risk of disease transmission because of interlinkages between environment health, biodiversity and human health.
- Building resilience through innovation and scaling integrated landscape management in, for example, rice-fish systems to link food systems, health, climate, water and livelihood resilience. For example, newly developed systems for integrating rice and fish in large deltaic landscapes of Asia can be scaled out for resilient and productive management of land and water systems.
- Building ecosystem health by reducing the footprint of agricultural systems and restoring degraded landscapes. This includes research to assess the impact of land cover/land-use change and water control infrastructure (e.g. dams) on ecosystem services and biodiversity, payment for ecosystem services, environmental flows and accounting for the impact of intensive farming on the environment and ecosystem health, as well as interventions such as collective management of the commons (e.g. forest reserves inhabited by zoonotic disease carriers).
- Measuring the socioeconomic performance of agroecological practices in relation to alternatives across environmental and demographic gradients and research on trade-offs and incentives associated with adoption of these practices. Resilience to pandemics and other global shocks can be strengthened by reducing reliance on input supply chains, increasing agrobiodiversity (impacting dietary diversity) and maintaining food yield while regenerating rather than degrading environment function.
- Promoting urban agroforestry by establishing SMEs in agriculture and forestry for women and youth to produce more crop and tree products in urban and semi-urban areas to mitigate food shortages during future crises. This intervention would have additional ecosystem health benefits.
- Assessment and forecasting of changes in water demand for irrigation because of disruption to the cropping cycle and implications for water risks to recovery of the economy and food system.
- Understanding the impacts of land-use change, climate change and intensification of livestock, wildlife and fish farming on disease emergence and developing interventions to mitigate these (e.g. genetically resistant livestock, intermittent irrigation to reduce vector-borne disease).

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to reducing poverty, enhancing food and nutrition security and improving natural resources and ecosystem services. Its research is carried out by 15 CGIAR Research Centers in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector.

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