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Leveraging COVID-19 recovery strategies to build climate-smart agrifood systems in developing countries

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Contents

Executive summary

The ongoing COVID-19 pandemic has jeopardized the stability of agrifood systems and the welfare of the rural households that are actively engaged in the different components of these systems, particularly in developing countries.

Efforts are underway to redress the negative impacts of the pandemic through investments to 'build back better'. These efforts represent an enormous opportunity to make significant and lasting contribution to the longer-term resilience and sustainability of agrifood systems in the context of climate change.

The objective of this report is to provide an overview of the current opportunities for harnessing short-term response and recovery efforts to address longer-term impacts on resilience and sustainability. The analysis focuses on the role of climate-smart agriculture (CSA) in recovery strategies and outlines concrete policy objectives that can be implemented by national governments and their development partners.

The first part of this report characterizes the relationship between the COVID-19 pandemic and the longer-term challenges associated with climate change. The study summarizes what the international and scientific community currently knows about the nature of the pandemic and its social, economic and environmental impacts, and how these impacts are linked with the impacts of climate change. These linkages form an important part of the conceptual basis of the argument for integrating a longer-term COVID-19 recovery investment strategy into a climate change mitigation and adaptation plan of action in low-income developing countries with significant rural populations and where the agriculture sector accounts for a large share of employment.

The second part of the report outlines specific policy options for investing in a green recovery from a smallholder agriculture perspective. The report emphasizes three main components. First, countries may prioritize investments in 'climate-adaptive social protection'. A core component of this approach is the coordinated delivery of CSA promotion and extension within the context of social protection efforts in rural areas.

Another component is a policy emphasis on digital advisory services, which are making large strides in many countries. To fine-tune these efforts and to maximize effectiveness, it is recommended to boost investments in expanding the evidence base. Investments in research for development need to address technical aspects (e.g. site-specific recommendations for climate-smart practices) and gather solid evidence about approaches for designing interventions that can maximize welfare and productivity gains at scale. Second, countries should reinforce these efforts through supporting policies and complementary investments in the conditioning factors that facilitate the deployment of more sustainable practices and technologies in smallholder-dominated rural economies more broadly.

This includes investments the target more resilient agrifood systems as a whole; the expansion and strengthening of access to rural financial markets; efforts to support innovation by different actors in the agrifood system; and a commitment to using public resources to leverage the ability of the private sector to respond to green opportunities.

Third, countries may situate these policy targets within a broader strategic framework that includes complementary investments in a 'greener rural economy'. This includes the promotion of alternative energy in agricultural value chains; the facilitation of supply chain management innovations; policies that encourage traceability and certification quality processes in value chains; and circular economy investments centered around, for example, increased reliance on organic fertilizer, waste reduction, and other recycling opportunities for plastic, paper and organic wastes.

Taken together, the policy options outlined in this report put the productivity, welfare and resilience of rural populations in the front line of pandemic recovery strategies. These policies are also fully consistent with longer-term goals of addressing climate change, as well as other related risks that predate the pandemic and will be just as pressing when the pandemic is over.

The policy options are consistent with the policy-oriented scientific literature, and thus reflect consensus about broad policy priorities. However, it is important to acknowledge that the specific ways in which these policies may be implemented locally may vary considerably across different contexts.

This is why the need for more research is so pressing. Decision-makers must evaluate tradeoffs between alternative strategies and implement policies that make the most sense in the areas where they are to be applied. Further public investment in building the evidence base will enhance the quality of policy evaluations.

Acknowledgments

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1. Introduction

The COVID-19 pandemic, despite the enormous costs of its socio-economic impacts, also provides an opportunity to revisit the collective thinking about how agrifood systems operate and how they can be made more resilient to future shocks.

This report provides an overview of the ways in which ongoing efforts to address the COVID-19 pandemic have opened up avenues for investments in longer-term resilience and sustainability of agrifood systems, particularly through the pathway of climate-smart agriculture (CSA).

This report provides guidance for further policy discussion.

The report is structured in two parts. The first part outlines the nature of the challenges presented by climate change and COVID-19, their interrelationships, and the potential role CSA can play in addressing these interrelated challenges.

The second part of the report outlines a set of policy options for enabling post-pandemic recovery efforts to contribute to longer-term resilience of agrifood systems through investments in CSA and associated enabling conditions.

2. COVID-19 and climate change: the intersection of two crises

2.1. Climate change was already a severe threat to agrifood systems

Before the onset of the COVID-19 pandemic, climate change had already become an urgent global crisis, perhaps particularly in the developing world.

Climate change has increased the threats to the stability of agricultural production and made the challenges of achieving food security more difficult in many areas of the world, most notably in low-income countries with large populations, inadequate health care facilities, and high rates of poverty and malnutrition (FAO, 2020a).

Even before the COVID- 19 pandemic struck, rising temperatures, fluctuating rainfall patterns and the increasing frequency and severity of extreme weather-related events have been associated with significant yield losses and increased poverty and hunger, and these events have revealed critical gaps in underdeveloped public health systems (Rasul, 2021).

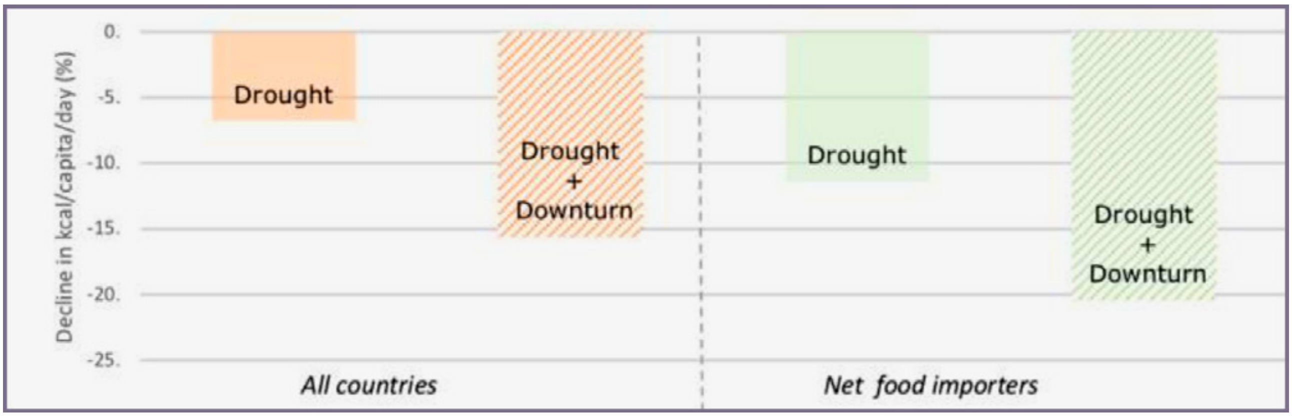
Disruptions related to weather shocks have direct impacts on agricultural production, which lead to fluctuations in global food prices. For example, global maize prices are strongly affected by the weather conditions in the Midwest of the United States of America (FAO, 2020a). Weather shocks not only undermine local food availability by reducing production, they also constrain food access and demand by lowering the incomes of agricultural workers and farmers.

Therefore, when weather disasters occur in low-income countries, particularly in countries with a high percentage of agriculture-dependent people, fluctuations in both food supply and demand occur, triggering significant detrimental impacts on food security (Ingutia, 2021).

2.2. COVID-19 has exacerbated existing vulnerabilities

The threats posed by climate change have been amplified by the global economic downturn (Figure 1). Since 2020, the COVID-19 pandemic has increased pressure on agrifood systems and disrupted the operations of these systems, which has made the challenges of improving public health and reducing food insecurity in areas where it is prevalent more difficult (Singh *et al*., 2020; Ingutia, 2021; Pradhan *et al*., 2021; Rasul, 2020; 2021).

Figure 1 - Estimated impacts of drought on average food supply



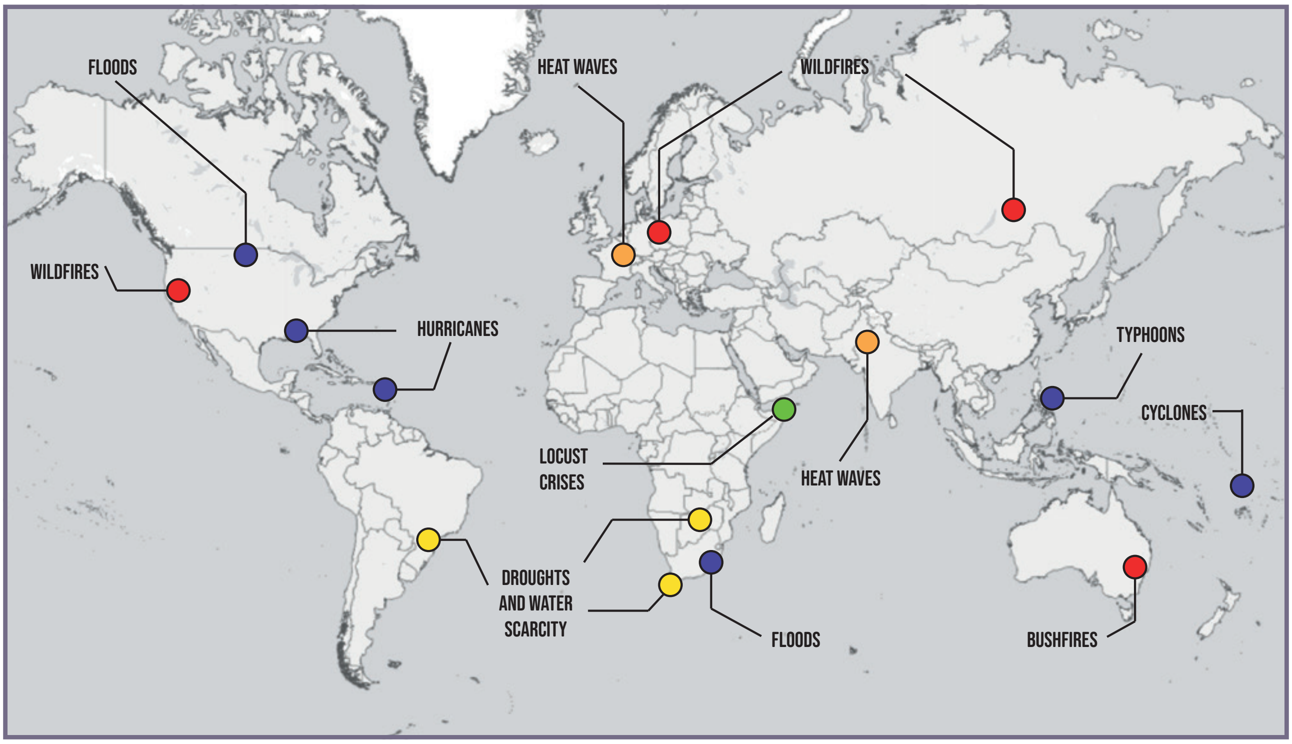
Source*: FAO, 2020a*

Over the past year and a half, poor countries have had to manage the double challenge of addressing the impacts of climate change and dealing with the disruptions caused by COVID-19 (Rasul, 2021). As the pandemic continues, the impacts associated with climate change are likely to further intersect with the impacts of COVID-19 globally (Figure 2). The most severe consequences of this confluence of crises will be experienced in developing countries, such as those in the Global South. These countries have large rural populations and their economies rely heavily on agriculture. This situation magnifies their exposure to weather-related shocks. Insulating mechanisms that can mitigate the impact of economic contractions are also less robust in these countries.

While managing the COVID-19 crisis, some countries have also had to deal with deadly heat waves, floods, and droughts that are causing serious hardships for thousands of people (IPCC, 2021). In April 2020, during the onset of the pandemic, Fiji experienced a category 5 tropical cyclone that destroyed key infrastructure and highlighted the challenges of disaster and public health management in the COVID-19 era (WMO, 2020a).

[1:] Figure 1 "shows the average percentage change in food supply in countries affected by a drought and countries affected by a drought in the context of a global economic downturn. The negative changes are measured relatively to countries not affected by a drought and their differences are statistically significant at 5 percent level."(FAO, 2020a, p.4)

Figure 2 - Climate hazards occurring during the COVID-19 pandemic



Source*: Phillips et al., 2020*

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

South African local authorities struggled to maintain physical distancing during flooding in informal settlements where the policy were already extremely difficult to implement, and in Zimbabwe droughts between June and September 2020 left millions without access to clean water and at risk of acute food insecurity (Phillips *et al*., 2020).

Rising temperatures are expected to increase the frequency and severity of future pandemics (Wyns and van Daalen, 2021). Therefore, the need to respond simultaneously to climate shocks and public health threats, and manage the risks associated with these threats, including their impact on agriculture and food security, has become a key priority.

2.3. Climate change and COVID-19 have similar disruptive impacts

Climate change and the COVID-19 pandemic impact agrifood systems in various ways, from the food production and processing to its distribution and consumption. However, while the impacts of COVID-19 have had a relatively rapid onset and spread quickly, the impacts of climate change are longer term. Nevertheless, the fundamental nature of the disruptions associated with the pandemic are similar to the weather-related disruptions that are expected to become increasingly frequent and more severe under many climate change scenarios.

Against the background of an ongoing and deepening climate emergency, the COVID-19 pandemic has put additional pressures on food systems and jeopardized world food security, and has, more than ever, laid bare the interconnections and interdependencies linking agriculture, society and the economy (Lioutas and Charatsari, 2021).

Deep covariant economic shocks caused by the pandemic have been affecting the cash flow and financial liquidity of producers, small and medium agri-businesses and financial institutions through a multitude of pathways, including inhibited production capacity, limited market access, loss of remittances, lack of employment, and unexpected medical costs (UN, 2020a). Developing countries, whose economies rely heavily on agriculture, have been the hardest hit due to limited mechanization and high labour intensity in the agriculture sector (Rasul, 2021).

Disruptions to agrifood systems

Climate change reduces crop yields

Changes in temperature and rainfall, water availability and hydrological regimes, along with increased exposure to extreme weather events affect the fundamental basis of agriculture and will have consequences for food production, food stability and food availability (Mbow *et al*., 2019; Rasul, 2021). Fluctuating climatic conditions may have significant impacts on crop yields. For example, a temperature increase of 1 °C may reduce crop yields of wheat by 5 to 10 percent (Asseng *et al*., 2015).

Many regions that lack irrigation will be similarly impacted by declines in precipitation (Iizumi *et al*., 2017; Ray *et al*., 2019). Research has shown that climate change may affect crops differently according to their context and traits. In Africa, research on the impacts of climate change have projected that maize, sorghum and millet yields are set to decrease substantially, whereas rice and cassava yields are not expected to be significantly affected during the 21st century (Ramirez-Villegas and Thornton, 2015, WMO, 2020b).

In South Asia, climate change is expected to result in a 50 percent decrease in wheat yields, a 17 decrease in rice yields and six percent decrease in maize yields, whereas rice yields in Sri Lanka may increase by six percent and in Pakistan by 7.5 percent (Bandara and Cai, 2014). However, these assessments are based on a number of uncertainties. Nevertheless, the general consensus is that changing climatic conditions will be increasingly detrimental to crop yields, and that it is imperative that this be taken into account when developing and implementing context-specific sustainable agricultural management and practices (IPCC, 2019).

Climate change shifts the areas that are suitable for some crops

In many agricultural areas, changing conditions are also expected to reduce the biophysical suitability of land for crop cultivation (Rasul, 2021). For instance, in Pakistan, the area suitable for wheat production has been predicted to decline by 30 to 35 percent by 2070, and the area suitable for maize production may decline by 23 to 36 percent (Khubaib *et al*., 2021). Similarly, in Bhutan, the production areas for rice and common bean have been projected to shrink under future climate scenarios (Chhogyel *et al*., 2020).

In East Africa, the areas suitable for the cultivation of common bean, maize, banana and finger millet are expected to contract significantly (Ramirez-Villegas and Thornton, 2015).

In areas where the potential for crop production is reduced, farmers may decide to manage their crops differently. They may choose to completely abandon their current crops in favour of crops that are more tolerant of the new conditions, or diversify their production to include a wider range of crops and varieties as a way of managing risk under fluctuating and uncertain climate conditions.

For example, in East Africa farmers have started cultivating a heat-tolerant variety of tepary bean (Phaseolus acutifolius) (Ramirez-Villegas and Thornton, 2015). Further systematic research is required to clarify the impacts of climate change on crop suitability and crop area (Rasul, 2021). Nevertheless, it seems clear that further investments in building the capacities of farmers to access production innovations are critical priorities.

Climate change modifies water availability

Adequate hydrological conditions and water availability are essential to maintain agricultural productivity and ensure food security. Meeting the growing demand for food relies on having sufficient quantities of water resources available at the right time (Rasul, 2021). By increasing the frequency and severity of extreme weather events (e.g. floods and droughts) and modifying hydrological conditions around the world, climate change will affect water availability for agriculture (IPCC, 2021).

These water-related impacts of climate change will not only significantly disrupt agricultural productivity, they will also have important economic and social repercussions. Sixty-four percent of the world’s population that is exposed to climate change-related disasters live in South Asia. In this region between 1990 and 2019, more than 1 000 climate-related disasters affected over 1.7 billion people and led to more than USD 127 billion in damages (GCA, 2021).

Exposure to climate-related disasters could push 62 million South Asians into extreme poverty, and floods alone could have an annual cost of 215 billion USD by 2030 (ADB, 2017; World Bank, 2021a).

At the same time as floods are affecting water availability and damaging infrastructure (e.g. irrigation canals, dams, and food transportation), increases in the frequency and severity of floods and droughts are worsening problems related to the protection of food and water resources, and this is expected to have increasingly negative impacts on agriculture and food security (Kirsch *et al*., 2012; Rasul, 2021; OCHA, 2014). To mitigate and counter these risks, adequate adaptation and mitigation measures must be taken promptly.

Pandemic containment measures have triggered labour shortages

The COVID-19 pandemic has caused significantly disruptions in the functioning of agrifood systems. Economic activity has been slowed down, travel has been prohibited, the movement of goods and services has been limited, and cross-border movement has been suspended to contain the virus (Singh *et al*., 2020; Laborde, Martin and Vos, 2020; Rasul, 2021).

Labour-intensive agricultural systems have found their supply chains disrupted and outputs compromised due to labour shortages resulting from the direct health impacts of pandemic and the indirect impacts related to control measures (Singh *et al*., 2020; Lamichhane and Reay-Jones, 2021; Rasul, 2021). Travel restrictions and border closures have had significant negative impacts on the supply of agricultural labour.

These measures have restricted the movement of seasonal migrant workers, who represent a significant share of the agricultural workforce in many countries, and as a result millions of women and men have been left without livelihoods and the harvesting of crops has been slowed (FAO, 2020b; OECD, 2020a). These disruptions have had an impact on many agricultural activities and throughout the entire supply chain, including the marketing, transport, distribution and consumption of agricultural goods and agricultural inputs (Rasul, 2021).

This situation has had significant social and economic consequences. For instance, the potential economic loss of India's wheat and rice growing states of Punjab and Haryana in 2020 was estimated at around USD 1.5 billion, primarily as a result of labour shortages (Singh *et al*., 2020).

Labour shortages and slowed operations have threatened the viability of many small and medium-scale farms and led to higher rates of poverty among more vulnerable farmers (FAO, 2020b; OECD, 2020a). These labour-related impacts have also highlighted the importance of migrant and informal workers in the smooth functioning of food systems.

Containment measures led to transport restrictions and market disruptions

Border restrictions and lockdowns have disrupted market access for both producers and consumers (FAO, 2020c). In some locations and times markets were completely closed, whereas other markets remained open but there activities were significantly disrupted.

Producers were unable to reach their usual outlets to sell their produce due to restrictions on the transportation of food to markets, which led to the collapse in prices for farm produce. For example, in India, farm prices for wheat have fallen significantly due to a lack of transportation facilities to deliver their harvest to markets (Dev and Sengupta, 2020). Additionally, the closure of markets (e.g. live animal markets) in many countries meant that small-scale producers could not sell their goods (FAO, 2020d). Logistical disruptions and a drop in demand have reduced sales and lowered prices.

For example American pig prices fell by roughly 27 percent the first week after lockdown because of the reduced access to markets, slaughterhouses and processing plants. Cattle producers in the United States of America have had to keep their stock longer or dump milk, leaving them with higher production costs or significant losses. In West Africa, many live animal markets were also closed, which caused the prices for cattle and small ruminants to drop by more than half, forcing pastoralist to destock massively (FAO, 2020d).

Increased vulnerability to food insecurity

Everyone all over the world is experiencing climate change. However, the people who are the most vulnerable to the impacts of climate change live the world's least-developed countries, where resources to cope with disasters are limited. Also vulnerable are the world's 2.5 billion smallholder farmers, herders and fishermen whose livelihoods and food security depend on the climate and on natural resources (Ingutia, 2021). Increasingly unpredictable weather patterns and natural disasters disproportionately affect these agricultural producers, by threatening their livelihoods and increasing the risk and prevalence of hunger, malnutrition and poverty (IPCC, 2021).

Climate change increases poverty and hunger

The majority of people experiencing food insecurity have low levels of income and limited purchasing power, a fact that puts into sharp relief the deep interlinkages between hunger and poverty (García, Pérez and Sanz, 2019; Ingutia, 2021). Price increases resulting from climate-related shocks to agriculture and the inelastic nature of global demand place the most pressure on low-income individuals in rural areas, who experience both increased food costs and reduced incomes due to declines in local agricultural production (Nelson *et al*., 2014).

These negative impacts of climate change on productivity together with endemic poverty have led vulnerable smallholders to resort to negative coping strategies, such as reducing food consumption, selling small assets, and employing unsustainable farming practices, which only further entrenches the cycle of vulnerability (Calef, Spano and Winder-Rossi, 2017; Ingutia, 2021).

Climate change increases public health and disease risks

By increasing heat stress, reducing air and water quality, and causing extreme weather events, climate change also negatively affects public health, particularly in low- and middle-income countries (WEF, 2020; Springmann *et al*., 2016; Watts *et al*., 2020).

Prolonged drought or increased rainfall expose people, and especially women and low-income communities, to pathogenic bacteria, parasites, mycotoxins and viruses. The increased exposure to pathogens has adverse impacts on human health, most notably on children's nutritional status, growth and development, and also diminishes labour productivity (Guerrant *et al*., 2013; Rasul, 2021; Rose and Wu, 2015).

Changes in climatic conditions can also increase the range of infectious diseases, especially water-, food-, and vector-borne diseases (Adve, 2020; Wyns and van Daalen, 2021). Dengue is a notable example of the increasing spread of the risk of diseases.

Due to increased temperatures, the incidence of dengue fever has increased in various parts of South Asia (Rasul, 2021; Sen *et al*., 2017; Uji, 2016). Research has also noted the possibility that higher carbon dioxide levels in the atmosphere could affect the nutritional composition of different crops, which will in turn have an impact on human nutrition (Myers *et al*., 2015; 2017).

For example, higher carbon dioxide concentrations may lower zinc and iron concentrations in C3 plants (i.e. plants in which first carbon compound produced during photosynthesis contains three carbon atoms), which include major crops that are critical to global food security (e.g. rice, cassava, soybean and cowpea).

These impacts of climate change pose a serious threat to health and food security around the world, particularly in agriculture-dependent economies, as greater exposure to health threats reduces the productive capacity of agricultural workers (Kjellstrom *et al*., 2016; Nag *et al*., 2009; Sahu, Sett and Kjellstrom, 2013). These threats have been exacerbated during the COVID-19 pandemic because the pandemic has reduced access to safe water, sanitation and hygiene (Rasul, 2021).

COVID-19 has increased acute food insecurity for vulnerable groups

Hunger was already trending upward before the COVID-19 pandemic, and the disruptions of agrifood systems, which have had an impact on agricultural production, has exacerbated the threat of food insecurity (World Bank, 2021a). The COVID-19 emergency is estimated to have significantly increased the number of people facing acute food insecurity (i.e. when a person's life or livelihood is in immediate danger because of lack of food). In 2020, between 720 and 811 million people were going hungry, approximately 118 million more than in 2019 (FAO *et al*., 2020).

Another indicator that tracks year-round access to adequate food, has shown that nearly 2.37 billion people, about 30 percent of the world's population, lacked access to adequate food in 2020, which represents an increase of 320 million in just one year (World Bank, 2021a). A recent post-lockdown study in 12 Indian states has shown that 50 percent of rural households are eating less than usual, and 68 percent have reduced the number of food items in their meals (Haq, 2020; Rasul, 2021). These impacts can have lasting consequences on the cognitive development of young children and have threatened the progress that has been made in reducing poverty and improving health (World Bank, 2021a).

As a result of soaring unemployment rates, income losses and rising food costs, 71 to 100 million people are now at risk of falling into extreme poverty, and for the first time since 1998 the share of the world's population living on less than USD 1.90 per day has increased (World Bank, 2020).

The COVID-19 pandemic has had a particularly severe impact the most vulnerable social groups, and the pandemic continues to affect these groups, notably migrant and informal workers, young people, women and Indigenous Peoples (UN, 2020a). The pandemic may exacerbate the already high vulnerabilities of these groups (FAO, 2020e).

Greater food insecurity and reduced incomes may encourage vulnerable household to resort to negative coping strategies, such as reducing the number of meals, choosing to have children leave school, cutting back on health expenditures, selling productive assets, and resorting to gender-based violence. These strategies will have long-lasting effects on the lives and livelihoods of all household members.

Youth

On an unprecedented scale, the pandemic has forced education and vocational training to move away from 'traditional' face-to-face encounters and become an online experience. This monumental shift may have long-term consequences for the affected students and is likely to further increase inequality for rural youth (FAO, 2020f).

As observed from previous health emergencies (e.g. Ebola outbreaks), the impact on education and vocational training is likely to negatively affect countries with already low learning outcomes, high dropout rates, and low resilience to shocks.

The impacts of the pandemic on education will be particularly acute in developing countries where distance learning remains out of reach for many people who do not have the means to connect online. This situation may cause further losses in human capital and diminish future economic opportunities for young people. Young people in rural areas are particularly hard hit by the crisis in terms of employment (FAO, 2020f). It has been shown that younger workers are often the first to have their working hours cut or to be laid off. Since 2008, economic declines have led to a much faster increase in the youth unemployment rate compared to the rate for adults (Puerto and Kim, 2020).

Rural young people, and especially young women, are highly vulnerable. Most of these young men and women are likely to be employed in the informal economy and often have low-paid, less secure and less protected jobs, and are more likely to live in working poverty. Furthermore, owing to the overall risk of increased poverty, rural youth aged 15-17 are at a greater risk of being forced into child labour and exploited to undertake hazardous work, especially in the agricultural sector (FAO, 2020f).

In addition, rural youth may not have access to the social protection mechanisms that are being implemented in response to the COVID-19 crisis to safeguard incomes, or these mechanisms may not take into consideration the specific vulnerabilities that young people face.

Women

The impact of COVID-19 is not gender neutral. Women make up on average 43 percent of the agricultural labour force. The pandemic has aggravated existing gender inequalities by reducing access to basic services, increasing women's responsibilities at home and in the workplace, escalating gender-based violence, and contributing to the loss of working opportunities for women in the informal sector (FAO, 2020g; UN, 2020b).

As women are more likely than men to be engaged in informal and precarious employment, they are more likely to be left without institutional safeguards (e.g. social insurance, pension or health insurance) in times of economic downturn (IASAC, 2020). This leaves women, and especially rural women, unprotected in case of illness or unemployment (FAO, 2020h).

Disease outbreaks also increase the duties that women, particularly young women, must carry out to care for elderly and ill family members, and look after children and siblings who are out of school. Consequently, women may be especially affected by the secondary impacts of the COVID-19 pandemic (ILO, 2018a). Women, and especially rural women, may face obstacles in accessing social assistance schemes (e.g. cash transfers and public works) due to mobility constraints, the burden of caring for others, discriminatory cultural norms, illiteracy and limited access to information on these schemes (FAO, 2020h).

The conditionalities of cash transfers may exacerbate women's time poverty and limit their ability to engage in income-generating activities (FAO, 2018a; 2018b; 2018c). To ensure that rural livelihoods are protected and the operations of agrifood chain are maintained, responses to address the impacts of COVID-19 must consider the key roles women play as food producers, farm managers, processors, traders, wage workers and entrepreneurs within agrifood systems and in their household in safeguarding food security and nutrition (FAO, 2020h).

Indigenous Peoples

There are 476 million Indigenous Peoples around the world. They make up 6.2 percent of the global population and, according to different sources, represent more than 19 percent of the population living extreme poverty (ILO, 2018b). Indigenous person are not a homogenous group. They live in over 90 countries, in rural and urban areas, in forests, savannahs, mountains, and along the coasts, in low-income, middle-income and high-income countries.

However, often they all share a history of discrimination and marginalization, and because of this, the COVID-19 crisis presents a challenge to their very existence (ILO, 2020). The lack of official recognition creates a barrier for Indigenous Peoples to access health services and receive social protection benefits. In Asia, some Indigenous Peoples do not have identification documents, and this can prevent them from accessing public services. In other regions, Indigenous Peoples are often not taken into consideration when collecting data, carrying out surveys and censuses, and compiling statistics.

This 'data invisibility' further complicates COVID-19 containment efforts and threatens the health of thousands of Indigenous Peoples. Indigenous groups have resorted to their own means to report cases and contain the spread of COVID-19. In some countries, indigenous groups are collecting and reporting their own data and are creating regional platforms to share information (FILAC, 2020; ONIC, 2020). Special care needs to be taken to ensure that measures to control COVID-19 are not used as a pretext to dispossess Indigenous Peoples and other groups with collective rights over natural resources and/or insecure property rights of their access to productive resources (FAO, 2020i).

If not properly addressed through policy measures, the social crises triggered by the COVID-19 pandemic and response measures may increase inequality, exclusion, discrimination and global unemployment in the medium and long term. The impact of the COVID-19 pandemic on health, incomes and purchasing power, and agricultural production, processing, distribution and consumption has severely eroded livelihoods and concerted efforts will be required to achieve a full recovery (FAO, 2020g).

Comprehensive, universal social protection systems can play a long-term role in protecting workers and reducing poverty rates, as these systems act as automatic economic stabilizers by providing basic income security and enhancing people's capacity to manage and overcome shocks. Social protection measures need to be geared towards enabling countries and communities to recover and become more resilient not only to pandemics, but also to the impacts of climate change and other multiple intersecting conflicts and threats (FAO, 2020g).

2.4. The logic of a unified response strategy

The brunt of the negative welfare impacts of the pandemic has fallen on people living in poverty (Valensisi, 2020, Kansiime *et al*., 2021). COVID-19 has hit low-income and vulnerable countries the hardest. In many cases, the pandemic has jeopardized the hard-won gains in poverty reduction and economic growth. Furthermore, the impacts of the pandemic are exacerbating existing inequalities, especially in the world's least developed countries.

The majority of the people living in poverty are located in rural areas and along the coasts, and are engaged directly or indirectly in agriculture and fisheries. For this reason, it is critical that recovery investments target agriculture and rural economies in developing countries. Response efforts will need to reach rural poor communities, and social protection measures will play a particularly important role in this regard (Gentilini *et al*., 2021).

Stimulus efforts that have a longer-term horizon must be geared toward transforming agricultural value chains. This set of policy and investment imperatives opens the door to thinking about how these investments may be designed to contribute as much as possible to making agrifood systems more robust, by increasing their resilience to future crises and safeguarding the welfare of the rural households that are actively engaged in the different components of these systems.

A central role for climate-smart agriculture

Building the resilience of agrifood systems includes promoting healthier and more sustainable food systems. What is needed are transformative approaches toward food production, public health and climate change that can deliver multiple benefits and contribute to achieving a number of sustainable development goals (Hepburn *et al*., 2020; Rasul, 2020; 2021; van Bodegom and Koopmanschap, 2020). This approach aligns with the objectives of climate-smart agriculture (CSA), which seeks to sustainably enhance efficiency in the use of resources and increase farmers' incomes; strengthen the resilience of agricultural systems to shocks, and, where possible, reduce greenhouse gas emissions (FAO, 2016).

Using an integrated and holistic approach, the CSA agenda focuses on developing site-specific assessments to identify optimally adapted agricultural practices and technologies that can improve the use and management of natural resources and maximize the efficiency of agricultural production systems and supply chains (FAO, 2016). CSA does not advocate for single type of production system. Instead the CSA approach endeavors to outline the necessary conditions for developing more sustainable and productive agricultural strategies that are adapted to the specific environmental and socio-economic characteristics of a given territory and the needs and aspirations of local communities.

CSA seeks to reduce trade-offs and build on synergies by supporting countries in implementing their national development plans and strategies, and achieving multiple objectives that meet the needs of communities in range of economic, social and environmental contexts. CSA enhances capacities, works to provide equitable and inclusive access to training and knowledge sharing, and encourages the participation of women and youth in the transition to more resilient agrifood systems.

The practical implementation of CSA rests on three axes: the assessment and application of sustainable technologies and practices; the creation of a supportive policy and institutional framework; and the formulation of investment strategies. CSA implementation along these three axes is achieved through five methodological action points (FAO, 2016):

Expanding the evidence base involves determining the present and projected impacts of climate change and the key vulnerabilities of existing agricultural production systems; identifying and evaluating the climate-smart practices that are best suited to respond to these impacts and aligned with specific national development objectives; assessing the needs of institutional and financial frameworks; and identifying the costs and barriers related to the implementation of these practices.

Supporting enabling policy frameworks (e.g. national agricultural development plans) allows for policy gaps to be filled and existing policy measures to be modified when necessary so as to enable full coordination between different institutions. Providing support to policy frameworks also ensures that diverse national development priorities are taken into account in CSA implementation, which can minimize any potential trade-offs that may need to be made.

Strengthening local and national institutions can foster cross-sectoral dialogue and increase the engagement of policy makers and other stakeholders in considering and supporting policies, and enhancing coordination that can facilitate the adoption of CSA practices.

Enhancing financing options is central to the effective implementation of CSA initiatives whose the principal sources of funding are national sector budgets and official development assistance. Developing innovative financing mechanisms to promote agricultural investments through climate finance and leveraging key national policy instruments so that they can unite national and international sources of finance are also crucial for successful CSA implementation.

Implementing CSA practices in the field requires incorporating the traditional knowledge that local producers possess about their environment and ecosystem, and fostering the active involvement of these producers in the identification and application of the best-suited CSA practices. Platforms for sharing knowledge and developing capacities, as well as training activities, are used as context-specific tools to promote the adoption of CSA practices on the ground.

With the advent of the COVID-19 crisis, a number of countries have recognized the potential synergies between CSA initiatives and the COVID-19 recovery measures. In other countries, however, the implementation of CSA initiatives has been impeded by mobility restrictions and/or the heightened financial constraints of the implementing institutions (van Bodegom and Koopmanschap, 2020).

A false dichotomy of intervention options?

The pandemic has impeded progress on CSA, and on a climate agenda more broadly, in at least three important ways.

Reallocation of government budget to COVID-19-focused initiatives

Many countries have temporarily shifted their budget allocations for CSA to other areas in order to focus on the pandemic response without considering potential synergies (van Bodegom and Koopmanschap, 2020). This is particularly the case in many African countries, where the COVID-19 pandemic has required governments to take unprecedented fiscal policy actions to protect public health and the economy.

Debt levels have soared while domestic budgets have been reconfigured on a large scale to provide much-needed funding to health sector, the business community and households. As a result, the compound impacts of the pandemic and climate change on agriculture and green activities have been put aside, despite the fact that agriculture is key to the economies of African countries (CABRI, 2021). Cabo Verde and South Africa and are noteworthy examples of countries where COVID-19 has limited the availability of public finances for climate action and other key priorities (CABRI, 2021).

In Kenya, important funds have also been directed to improve testing for COVID-19, implement safety measures and support infrastructure, whereas the recent floods, which led most rivers and lakes to reach their highest recorded levels, were neglected to the extent that victims were left homeless and, in some cases, unable to evacuate to schools that had been protected to serve as COVID-19 quarantine centers (van Bodegom and Koopmanschap, 2020).

Reduction of government workers to essential staff

By reducing the number of government and NGO workers to essential staff, the governments of several countries have considerably slowed down CSA activities in their delivery of extension services. This is the case in Liberia, where the COVID-19 crisis has had a negative impact on the country's climate-smart activities (van Bodegom and Koopmanschap, 2020). Similarly, in Uganda, green activities are at standstill, as environmentalists are not considered to be essential workers under lockdown guidelines, and hence cannot carry out fieldwork and verify environmental changes. This situation has resulted in important gaps in data (van Bodegom and Koopmanschap, 2020).

Detrimental effects on the environment linked to COVID-19 initiatives

A number of countries have reported negative environmental impacts due to COVID-19 related initiatives. For example, in Nigeria, the fumigation of the federal capital territory has been considered harmful to the environment. In Zimbabwe, the rampant and uncontrolled use of sanitizers and soap in areas without adequate disposal facilities has had harmful impacts on both the environment and health. In other countries, such as in Ethiopia, the many anti-COVID-19 masks being used are a threat to the environment because sufficient measures have not been put in place to handle the extra waste (van Bodegom and Koopmanschap, 2020).

COVID-19 as an opportunity to promote climate-smart agriculture and scale up climate-resilient food systems

In other instances, the COVID-19 crisis has highlighted the need to push for transformative change and the adoption of a food systems approach, and has helped advance the CSA agenda. Beyond the temporary effect of reducing pollution and carbon dioxide emissions in many parts of the world (Parida *et al*., 2021), the response to the COVID-19 pandemic has created an opportunity to make progress in restructuring agrifood systems so that they are more resilient to shocks (ASEAN, 2020; Phillips *et al*., 2020; van Bodegom and Koopmanschap, 2020).

The exposure to the dual threat of the COVID-19 pandemic and climate change has focused attention on the importance of integrating climate actions and investments into COVID-19 recovery strategies for the food, agriculture and forestry sector. Regional and national policy makers have been obliged to develop green recovery plans that focus on the relationships between economic, environmental and public health (ASEAN, 2020). The European Green Deal is an important plan that has been formulated to transform the European Union (EU) into a resource-efficient economy.

The objectives of the plan are to ensure no net emissions of greenhouse gases by 2050, promote economic growth that is decoupled from resource use, and make sure no one is left behind. The European Green Deal will be financed by one-third of the EUR 1.8 trillion investment for the NextGenerationEU Recovery Plan, and the European Union's seven-year budget (European Commission, 2021).

Without policy measures to decrease the impacts of the dual threats posed by the COVID-19-induced economic crisis and potential weather shocks, and increase resiliency to withstand similar future crises, potential reductions in national food availability may be far worse than previously seen and may persist longer.

The unprecedented challenges stemming from these dual crises require innovative strategies and approaches to make agriculture and food systems better able to deal with both COVID-19 and climate-related threats (Rasul, 2021). COVID-19's disruptive forces can be leveraged to accelerate the transition to more sustainable food systems.

To establish agrifood systems that can withstand the combined impacts of global pandemics and climate change, countries should learn from existing best practices and make innovations to leverage investments geared to COVID-19 recovery to support resilient agrifood systems and align these investments with existing policy frameworks that promote resilient, inclusive, and climate-smart agriculture systems.

Low-income countries may have limited budget to allocate to climate-smart or green strategies, given that several other high-priority issues absorb most of their resources. The COVID-19 emergency has reduced resource availability even more. However, these are precisely the countries that would benefit the most from adopting a synergetic approach that integrates COVID-19 recovery measures and sustainable investments.

The scenarios for many parts of Africa, Southeast Asia and Latin America project that climate change will increase the already high vulnerabilities of rural people in these regions. Country-specific projects that promote CSA and the mitigation of climate-related risks can be taken as examples of sustainable policies that have both increased resilience and promoted growth, a balance that is critical for post-COVID-19 recovery strategies. Examples of these projects are the Climate Smart Irrigated Agriculture Project in Sri Lanka, and the Climate Smart Agriculture Investment Plans in Bangladesh, Côte d'Ivoire, Mali, and Zambia, which were partially financed with the support of FAO and the World Bank (World Bank, 2019; FAO, 2021).

3. Leveraging COVID-19 recovery strategies to develop climate-smart agriculture

This section provides an outline of the three major components of a climate-smart pandemic recovery strategy: (i) climate-adaptive social protection for the rural poor, (ii) enabling conditions for climate-smart productive investments; and (iii) complementary investments in other components of a greener rural economy. The section also includes a short discussion of resource mobilization and fiscal policy strategies that national governments may pursue. The section concludes with a review of the (limited) evidence that is currently available on the extent to which countries in the Global South are engaging with these strategies.

3.1. Climate-adaptive social protection

COVID-19 as an opportunity to promote CSA and scale up climate-resilient food systems

Both conditional and unconditional cash transfers are becoming increasingly widespread mechanisms in social welfare interventions in developing countries. There is a nascent body of empirical evidence indicating that some kinds of social protection measures can foster the adoption of technology. Several studies have examined the impact of cash transfers on agricultural production, where the primary goal of the transfer was not to achieve agricultural outcomes. Todd, Winters and Hertz, (2010), Boone *et al*. (2013) and Handa *et al*. (2015) have found positive but modest impacts of small, regular cash transfers on agricultural investments on production in Mexico, Malawi, and Zambia, respectively. Haushofer and Shapiro (2016) have found that in Kenya lump sum transfers are more likely to be used for productive investments in agriculture compared with regular monthly transfers.

Other studies have examined transfers that explicitly target agricultural outcomes. Beaman *et al*. (2014) found that cash grants in Mali had large impacts on farm investments and production outcomes. A study undertaken in Malawi, indicated that large cash or input transfers had significant impacts that persist into subsequent seasons (Ambler, de Brauw and Godlonton, 2018).

In contrast, a 2014 study of large cash grants to Ghanaian farmers found only modest impacts, relative to weather insurance as an alternative approach (Karlan *et al*., 2014).

Positing that differences in framing may underlie some of these empirical outcomes, Ambler, de Brauw and Godlonton (2020) have evaluated a two-year programme in which a one-time cash transfer was paired with farm management advice for smallholders in Senegal, and have documented large and persistent impacts on the uptake of technology.

Scognamillo and Sitko (2020) have used observational data to document positive effects of safety net transfers on CSA adoption in Malawi. They have found evidence that participation in the Malawi Social Action Fund (MASAF) significantly increases the probability that farm households will build soil water conservation structures and apply organic fertilizers, both of which are resource-intensive CSA practices. They find that these usage effects persist over multiple agricultural seasons. The joint effects of CSA adoption with the social welfare programme substantially increased productivity and welfare outcomes.

Their results suggest that the CSA agenda can be advanced by explicitly integrating existing social protection interventions with the promotion of CSA practices. The work by Ambler, de Brauw and Godlonton (2020) suggests that delivery of CSA extension within the context of a cash transfer may pay particularly high dividends in terms of induced uptake.

This body of evidence generally reinforces the idea that social safety nets and transfers can directly contribute to the adoption and scaling up of promoted CSA technologies. However, the diversity of the findings across implementation contexts also underscores the importance of additional empirical research to clarify how best to design such programmes, and in particular how to leverage the greatest impacts on CSA investments at scale.

A comprehensive treatment of design considerations for social protection programming in developing countries in the context of pandemic response and recovery is beyond the scope of this report. However, there are some broadly applicable recommendations that can be cited. Gerard, Imbert and Orkin (2020) argue that developing countries can and should cast broader emergency safety nets by using a wider patchwork of solutions than higher-income countries.

They suggest expanding existing social insurance systems and other social assistance programmes, and involving local governments and non-state institutions in identifying and assisting vulnerable groups that would be otherwise difficult to reach. These recommendations map well onto the idea that more inclusive promotion of CSA technologies will have deeper benefits (Meinzen-Dick, Bernier and Haglund, 2013; Farnworth *et al*., 2016; FAO, 2017).

Invest in opportunities linked with the rise of digital advisory services

Information and communication technology (ICT) may be used to customize CSA recommendations to meet the particular characteristics of the site, its biophysical environment, local markets and the types of households in the community.

This customization may make the recommendations more effective and, thus, speed up adoption. Existing evidence suggests that site-specific advisory services improve the adoption of recommended practices and increase production efficiency (Cole and

Fernando, 2020; Oyinbo *et al.*, 2021; Ayalew, Chamberlin and Newman, 2021).

ICTs may also enhance social protection efforts (Handayani *et al.*, 2017).

For example, integrating ICTs into social protection programmes may improve accuracy and efficiency when targeting and contacting beneficiaries, delivering services, and carrying out monitoring and evaluating activities.

Advisory services and technology promotion strategies should be designed with diverse audiences in mind to maximize the system-wide inclusivity of the desired technological changes. Abate *et al.* (2019) and Lecoutere, Spielman and Van Campenhout (2019) show that tool design features related to the gender correspondence between video extension presentations and extension recipients can have important impacts on the perceptions, intentions and behavioural outcomes related to the uptake of technology. Spielman *et al.* (2020) show more broadly that design features in ICT-enabled advisory tools can have a large impact on extension outcomes.

These considerations are important, considering the well-documented barriers that women and other marginalized groups have in accessing traditional advisory service channels (Ragasa *et al.*, 2013).

Invest in expanding the evidence base on what works and where

As mentioned above, the broad contours of effective strategies linking CSA with social protection seem clear. However, the details that need to be considered to optimize the implementation of these linkages in different contexts would benefit from more empirical research. It would be particularly valuable to invest in evaluation activities that can test alternative modes of framing and content delivery, as well as investigations into how best to design transfers to maximize investment potential of beneficiaries (e.g. comparing large lump sum transfers to continuing payments over a given time interval).

Many of the practices and technologies that constitute CSA are well understood for some contexts, but there is still a need to systematically expand the evidence base for identifying best practices for different conditions (i.e. what does 'climate smart' mean in different biophysical and socio-economic contexts) (Lipper *et al.*, 2014).

These research needs existed before the pandemic and have been generally underfunded (Lipper *et al.*, 2014). In the post-pandemic period, research should not be seen as an activity that is competing for investment resources, but instead should be recognized as a fundamental investment that is needed for expanding the potential for CSA to deliver dividends in terms of increased productivity and greater resilience for producer households. Investments in building the evidence base can also contribute to enabling other agricultural value chain actors to identify and respond to opportunities to provide CSA services.

3.2. Enabling conditions for climate-smart agricultural transformation

The adoption of CSA, and, more generally, the uptake of technologies and practices that can support sustainable agricultural intensification, are determined by a broader set of factors that define the conditions under which agricultural producers operate. This section highlights several areas in which proactive policies and targeted recovery investments may contribute to establishing enabling conditions for CSA in agrarian economies.

Invest in more resilient agrifood systems

The weaknesses in agrifood systems that have been laid bare by the pandemic have highlighted the importance of policies and investments that can improve the sustainability and resilience of these systems. In most parts of the world, food expenditures constitute a large share of household expenses for people living in poverty in both urban and rural areas. For example, in sub-Saharan Africa, food is the largest household expense, accounting, on average, for 44 percent of the household budgets, and the share remains relatively high even in rural areas where smallholder farming is dominant (Balineau *et al*., 2021).

Recent policy-oriented assessments of the functioning of agrifood systems have been critical of the practice of financing isolated projects that concentrate excessively on production instead of following a holistic approach that considers the many components of the entire agrifood system (e.g. logistics, distribution, consumer preferences and market governance)(e.g. Balineau *et al*., 2021). More systemic analyses of agrifood systems have adopted a ‘farm to table’ perspective that extends from producers to consumers. Efforts to strengthen supporting institutions along the length of value chains will be important in this respect. In Europe, the Farm to Fork strategy has stressed the importance of a adopting a producer-consumer perspective and allocated specific funds to projects that are in line with this strategy.

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Promote the development of complementary financial markets

Implied in the preceding discussion was a functional set of complementary markets. Markets for financial services, particularly savings, credit and insurance, are fundamental for rural development, but they are still at nascent stages in many developing countries (Conning and Udry, 2007, Amha and Peck, 2019). However, the rapid expansion of mobile banking operations (e.g. M-PESA in East Africa), which has been made possible by the ICT revolution over the past 15 years, has been a game changer in much of the world (Asongu and Odhiambo, 2019).

Fintech (financial technology) and agfintech (agriculture financial technology) applications are likely to represent major areas of innovation in coming years. Policies should support the coherent development of the fintech and agfintech sectors, and facilitate access to the services they provide.

Support innovation in agrifood systems

Enabling farmers and other value chain actors to innovate is key component of resilient agrifood systems. This is particularly true for production and marketing contexts where CSA and sustainable intensification technologies need to be fine-tuned to work well (Jayne *et al*., 2019). Peer learning, mother and baby trials, farmer field schools and innovation systems are all promising institutional approaches to fostering innovation in production (Snapp, 2002, Jayne *et al*., 2019, Kanda *et al*., 2019).

Similar approaches may be taken to encourage the latent innovation elsewhere in agricultural value chains, many of which are undergoing rapid changes. For example, the 'supermarket revolution' is creating opportunities for institutional and managerial innovations (Reardon, 2015; Krishnan and Foster, 2018; Devaux *et al*., 2018).

Supporting the development of forums for the exchange of knowledge among peers, or marketplaces for ideas for processors, distributors and marketers of agricultural products are other examples of activities that could stimulate innovation in supply chain management.

In a related area, focus has been placed on building capacities and skills through entrepreneurial and employment training, particularly for unemployed rural youth.

These training programmes are arguably easier to design and carry out than successful investments in innovation, and perhaps as a consequence, they have been implemented on a large-scale in recent years. However, the evidence for the effectiveness of these training programmes is mixed. Studies that have focused on training that is specifically tailored for starting new businesses have found that it has significant impact, particularly in the short term (Gavigan, Ciprikis and Cooney, 2020; Klinger and Schundeln, 2011; Premand *et al*., 2012).

However, the effects on the long-term survival of existing businesses are relatively more modest (Giné and Mansuri, 2011; Mano *et al*., 2012; McKenzie and Woodruff, 2013). A recent meta-analysis found that traditional training programmes have a small but significant effect on profits and sales of businesses that received training (McKenzie, 2021). However, a 2021 review indicates that the typical business training that has been evaluated has not created additional employment, green or otherwise (McKenzie *et al*., eds., 2021).

Fox and Kaul (2018) come to a qualitatively similar conclusion for youth-focused skills training, but they acknowledge that basic educational investments are likely to have high, generalized payoffs. Training in agriculture (professional, workshops and on-farm training) has been shown to have positive impacts on a number of outcomes, including crop production and farm profits. The effectiveness of these programmes tends to be higher for more educated participants (Tambi, 2019; Kijima, Ito and Otsuka, 2012: Phillips *et al*, 2014). Increases in the adoption of improved cultivation practices as a result of training activities have also been noted (Kijima, Ito and Otsuka, 2012).

Despite the mixed evidence on entrepreneurial training, the findings on agricultural training support the hypothesis that one of the major constraints on the growth in farming productivity in sub-Saharan Africa is the absence of effective extension systems (Kijima, Ito and Otsuka, 2012).

Support the ability of the private sector to respond to green opportunities

Harnessing the power of the private sector is an important strategic objective for encouraging innovation in technologies, services and supply chain management. In some cases, companies and investors are already demonstrating leadership and innovation in green strategies.

Policy signals can help others stakeholders to align their activities with the private sector agenda. Regulations and incentives that encourage the shift to low-carbon development, a circular economy and other sustainable approaches should be promoted. Policies in this area might include tax incentives for activities that make use of alternative energy sources, increase recycling or foster traceable value chain management.

At the same time, policies that stifle innovation (e.g. subsidies for fossil fuel use or land policies that favour agricultural expansion) can be reformed. Private sector green innovation can also be the explicit target of international partnerships and financing (e.g. through competitive awards). Cooperation between the private sector and research communities is pivotal for providing the agrifood sector with specific innovations, especially applications for circular economy, precision farming and digitalization.

Governments may design tax incentives that target particular groups, geographic areas, value chains and groups of farmers that are currently underserved in order to leverage private sector investment where it is most needed. For example, tax incentives may explicitly target vulnerable groups that are at relatively greater exposure to the risks associated with climate change. Tax incentives may also target investments to financial services that can improve the capacities of small-scale producers and other value chain actors to better manage risks.

Finally, investment in public goods (e.g. spatially disaggregated data on rural households) may help the private sector to gauge the potential demand for services and input supplies for value addition in prospective value chains and enable them to invest with greater confidence.

3.3. Supporting other green investments in the rural economy

Promote the adoption and extension of alternative energy in agricultural value chains

Reducing dependency on fossil fuels, particularly diesel, in rural value chains is an important part of a more comprehensive longer-term green recovery strategy. The more rural farm and non-farm economies grow, the more attenuating the dependency on fossil fuels will become a priority. Agrifood systems consume about 30 percent of the world's energy and energy is responsible for a third of the emissions for agrifood systems (IRENA and FAO, 2021).

It is crucial to provide access to modern energy sources along agrifood value chains to reduce food losses and waste. Ensuring the sustainability of agrifood systems requires adopting a cross-cutting, value chain approach that takes into consideration energy efficiency, availability and affordability.

Fortunately, the technological and economic scope for meeting these challenges in developing regions is growing, particularly in areas with potential solar and wind resources (Arndt *et al*., 2019). Opportunities for developing countries to 'leapfrog' into modern energy sources will require concerted policy formulation and public-private coordination. However, these efforts could potentially pay enormous dividends in terms of reduced emissions, job creation and the many knock-on benefits that come with expanding access to energy. These dividends could be particularly significant in Africa, where rural electrification still lags behind other regions.

There are an estimated at 1.4 billion people who are not connected to national electrical grids (Overland, 2016). These people typically rely on diesel generators to meet the energy needs of their households and businesses. Burning diesel generates carbon emissions and is linked with multiple toxic by-products (e.g. benzene, arsenic and formaldehyde). The spillage of diesel and consequent contamination of land and water resources during its transportation and storage also damages the environment.

Alternative approaches, such as renewable energy mini-grids, may be part of the solution (Yadoo and Cruikshank 2012; Liu and Bah, 2021; Bukari *et al*., 2021). However, the rate of failure of mini-grid projects is high (Ikejemba *et al*., 2017). An analysis of these cases determined that the factors most often cited as the reasons for failure were the absence of local maintenance expertise and a lack of acceptance of the technology (Ikejemba *et al*., 2017). Thus, initiatives that can integrate the promotion of new technologies into broader investment strategies are critical. Similarly, linking renewable energy investments with initiatives to support local businesses and income generation may build synergies among these investments.

Policies that provide incentives to increase fuel efficiency and/or adopt alternative energy sources for transportation, as well as for farm mechanization and food processing and marketing, would also be extremely useful. Current vehicle import policies in many developing regions encourage the importation and use of inefficient vehicles acquired through international second-hand markets (for information on the situation in Africa consult AASA, 2020; Ayetor *et al*., 2021). Even where restrictions on the importing of second-hand vehicles are in place, they are not always well enforced (Ayetor *et al*., 2021). In Africa, 22 countries currently have no restrictions on the importing of second-hand vehicles, while 27 countries have age limitations of 3-15 years on imported vehicles (AASA, 2020).

However, even with current stocks of equipment, creative transportation policies can considerably curtail emissions and reduce other environmental costs (Berg *et al*., 2017). For example, circulation restrictions that address temporal and/or spatial patterns in traffic congestion may provide incentives that can drive changes that can contribute to greener transportation systems.

For farm mechanization, solar water pumps have enormous potential and are already in use in many areas (Schmitter *et al*., 2018, Wazed *et al*., 2018). Other forms of solar powered agricultural mechanization are rapidly being developed for low-income rural settings (Gorjian *et al*., 2021). The role of mechanization in complementing CSA practices is well understood (Lopez-Ridaura *et al*., 2018). This fact underscores the value of a green mechanization policy.

Support innovations in supply chain management

Investing in traceability and certification processes generally would be a useful complementary area. Certification of one or more of the end products of a value chain as organic or sustainably produced can help capture value for farmers. Even where certification does not result in a price premium, it may enhance market access by demonstrating the dependability of the suppliers (Westlake, 2014).

In other cases, certification may be a prerequisite for entry into certain markets. However, certification may be difficult for small-scale producers who do not have the skills or capital investment capacities to adopt the required certification measures and supporting practices (e.g. record keeping).

These constraints are particularly acute for independent producers, and strengthening producer groups may help to farmers to overcome them. However, in all cases, the benefits of certification, particularly in the form of higher producer prices, need to be sufficient to justify the costs of certification.

Invest in a circular economy for the recycling of organic waste

Policies targeting the development of a circular economy founded on the recycling of organic material could pay enormous dividends for agricultural sustainability and create new jobs (Bekchanov and Mirzabaev, 2018; Goyal *et al*., 2018; Sherwood, 2020).

Despite the large potential, the markets for the recycling of organic waste, particularly markets centred around urban to rural nutrient flows, are non-existent or at the nascent stages of development in most developing countries (Goyal *et al*., 2018).

However, a number of case studies have indicated that there are viable business models to be pursued (for example from Sri Lanka, see Bekchanov and Mirzabaev, 2018). Public support could target development in this area.

Reduce food loss and waste

Paying greater attention to food loss and waste would complement these investments. About one-third of global food production is lost or wasted (FAO, 2011). Reducing food loss and waste makes value chains more efficient, and lowers the costs of meeting food demand both globally and in developing countries.

The higher price elasticities of food consumption by low-income consumers in developing countries mean that lower production costs along the value chain, which can translate into lower food prices, can have major impacts on food security. Greater food security in farming households, in turn, may allow for greater productive investments, including investments in CSA practices.

Policy targets may include expanding the access on farms and in villages to improved storage (e.g. Purdue Improved Crop Storage (PICS) bags and warehouse receipts systems). This may involve investments in public infrastructure, as well as policies designed to facilitate market development, and/or institutional reform in the case of publicly managed warehouse receipts systems. For fresh markets (dairy, meat, horticulture), improved cold storage chains may require public infrastructure investments and policy incentives to stimulate private sector investment.

Enabling access to cold value chains should also focus on distributional issues, as low-income producers are typically the least able to participate in these chains.

The resource requirements for these investments will not be easy to meet, particularly for fiscally constrained national governments in the developing world. An increasing number of voices are advocating for supporting pandemic ‘green recovery’ efforts through the mobilization of investments that promote decarbonization.

One of the advantages of explicitly linking recovery efforts to climate-smart investments is that opportunities exist to draw upon various sources of climate finance, such as the Climate Investment Funds (CIF), the Green Climate Fund (GCF), the Forest Carbon Partnership Facility (FCPF) and the Global Environment Facility (GEF).

The investment case is compelling. A report by the New Climate Economy indicates that effective climate action enabled by climate financing could deliver more than USD 26 trillion net global economic benefits by 2030, compared with a business-as-usual scenario. These benefits include the creation of more than 65 million new low-carbon jobs by 2030 and the avoidance of over 700 000 premature deaths from air pollution (Global Commission on the Economy and Climate, 2018).

However, gaining access to climate financing requires a precise description of the specific ways in which the investments will contribute to climate-related transformational change (Viguri *et al*., 2021).

Project designers should clearly indicate whether the projects to be supported with climate financing will build on ongoing cooperation (e.g. with regional development banks) and will be reoriented them toward climate-resilient development by covering incremental costs of these changes, or advocate for new interventions, such as policy reforms, the development of new markets, and capacity building.

This will not be easy. A recent analysis of climate financing found that funders have not been very successful at targeting climate adaptation finance to the most vulnerable countries in the developing world (Savvidou *et al*., 2021).

3.5. Monitoring investments to date

It is pertinent to inquire into how current pandemic response and recovery efforts in the developing world are aligning with the strategies outlined above. Unfortunately, despite the number of agriculture and green economy projects that were developed in 2020 as part of COVID-19 recovery plans, the information available to carry out such an assessment is still quite limited. Initiatives in Kenya, Nepal and Pakistan that have incorporated some degree of investment in green elements in the pandemic stimulus packages are among the most noteworthy (Keane *et al*., 2021).

Nepal was the most ambitious, with a dedicated package of over USD 7.4 billion for “greening existing projects and for new initiatives targeting nature-based solutions, green and resilient infrastructure, general resilience-building and private sector green recovery” (Keane *et al*., 2021, p. 42).

The Climate Smart Irrigated Agriculture Project (CSIAP) is an important initiative promoted in Sri Lanka with the support of the World Bank, FAO and the Sri Lankan Government. The project, which began in 2019 to improve the productivity and climate resilience of smallholder agriculture, has played a key role in Sri Lanka's COVID-19 relief and recovery plan. In 2020, the project invested USD 1.72 million in five major production programmes: the Cluster Villages Development Programme, the COVID Yala-2020 Programme, the Inter-Season Cultivation Programme, the Maha-2020 Cultivation Programme, and Climate-Smart Nutrition-Sensitive Home Garden Programme. These programmes, which have prioritized food production using CSA technologies and practices, crop diversification and inter-season and off-season cultivation, and household-level nutritional security, have benefited more than 19 900 farming households (World Bank, 2021b).

Another initiative has been developed through the collaboration of the Global Green Growth Institute (GGGI) and the Qatar Fund for Development (QFFD). In 2020, this collaboration resulted in a 3-year agreement of USD 9.85 million to support four projects: the Eastern Caribbean Green Entrepreneurship Initiative, the Pacific Green Entrepreneur Network, Climate-Smart Agriculture for Kiribati, and Solar-Powered Irrigation or Climate-Smart Agriculture in the Senegal River Valley.

These projects aim to enhance capacities and innovation in climate resilience in the target countries; create more than 8 500 direct jobs; improve incomes of more than 5 500 farmers; and support more than 600 micro-, small- and medium enterprises in local green industries. In particular, investments in CSA are intended to increase local production, improve crop yields, and raise awareness of the nutritional value of vegetables by providing training in climate-smart techniques and equipment for CSA and solar irrigation systems. In Senegal, income support to farmers has also been envisaged (GGGI, 2020).

In the attempt to collect data on responses to the COVID-19 crisis in a more systematic way, a number of repositories of policy actions and expenditures for several countries have been created and are being periodically updated. As they are large-scale data repositories, the information on expenditures contained in these databases may not be disaggregated by sector, and the precise nature of these investments may not be clearly defined. Nevertheless, they offer a global snapshot of the recovery spending measures, and provide a useful starting point for assessing how green recovery efforts have been carried out in the agricultural sectors of developing countries. These databases are summarized in Table 1.

One of the most pertinent of these databases is the Global Recovery Observatory (GRO), a weekly updated database that tracks COVID-19-related fiscal spending policies announced by the 50 leading economies and assesses these policies for their potential environmental and socio-economic impacts (O'Callaghan, *et al*., 2021). The GRO database covers several developing countries, including China, Ghana, India, Kenya, Nigeria, Thailand and several Latin American countries. The database reports on a number of green policies in agriculture.

One of these is a policy in Jamaica that has been promoted by the Ministry of Industry, Commerce, Agriculture and Fisheries to provide assistance to farmers and fisherfolk. One billion Jamaican dollars have been allocated for the provision of equipment, machinery and infrastructure for agriculture as well as climate-smart production practices and technologies. In Mauritius, the European Union has funded projects to support CSA and research and development in sustainable agriculture.

The projects are designed to promote agroecological farming, reduce the use of pesticides, and increase the resilience of agriculture to climate change. Despite some notable efforts to promote green projects, however, the global recovery spending has fallen short of national commitments to build back more sustainably. An analysis based on the GRO data and led by the Oxford's Economic Recovery Project and the United Nation Environment Programme (UNEP) finds that only 18 percent of announced recovery spending can be considered green (O'Callaghan and Murdock, 2021).

This percentage falls to 2.2 percent when the analysis is limited to Latin American and Caribbean countries (GFPN, 2021), which raises concerns about the efforts countries in this region are making to achieve a green recovery.

Gentilini *et al*.'s 'living document' on social protection measures implemented in response to the COVID-19 pandemic is another potential source of information about some kinds of recovery investments in the agricultural sector.

However, the criteria for the inclusion of measures in the database are not clear, and the potential for omission of key measures is unknown. Nevertheless, the database offers some starting points for further investigation. As an example, for Cayman Islands (UK), the database of Gentilini *et al*. (2021, p.162) records that:

The government launched the COVID 19 Farmers' Assistance Programme to increase farmers' capacity to yield greater quantities of high-quality produce and livestock. Each successful applicant received a voucher card to purchase seeds, fertilizers, and other essential agricultural inputs from the Department of Agriculture. The programme, which began in December 2020, was developed to stimulate increased agricultural activity by providing USD 1 million in funding for farmers to use towards the purchase of products and services from the Department of Agriculture.

The degree to which these investments actually or potentially map onto CSA or other green recovery elements is unclear from the information provided.

The Organisation for Economic Co-operation and Development (OECD) Green Recovery Database (2021) tracks COVID-19 recovery measures that are likely to have positive or negative environmental implications in 43 countries: the 37 members of the OECD along with Costa Rica, Brazil, China, India, Indonesia and South Africa.

The measures are categorized by sector (including agriculture) and the type of measure (e.g. grant, subsidy, training, regulatory change). A summary description of each measure is also provided. The description often includes the official name of the measure and the funders, along with useful links to other sources in case further information is desired. Analyses of the database find that the spending allocated to green measures represents only around 17 percent of recovery spending (two percent of total COVID-19-related spending) announced by governments, which confirms findings based on the GRO database. The geographical scope of this database, however, is limited as its primarily focuses on advanced economies.

The International Monetary Fund (IMF) COVID Policy tracker is another database that summarizes the key fiscal measures governments have been announced or implemented in selected countries in response to the COVID-19 pandemic. Currently, the database contains data for the 20 G20 advanced and emerging market economies, 26 non-G20 advanced economies, 82 non-G20 emerging market economies, and 59 low-income developing countries. Limitations of this database include the fact that expenditures are not disaggregated by sector and detailed information about the focus of each measure is missing.

The existing evidence, although still limited, shows that the efforts countries have made towards green and sustainable growth are quite scarce compared to the total investments directed to COVID-19 recovery measures. This finding indicates that the world is not yet on track for a green recovery. Governments must be called upon to invest more sustainably. This means according priority simultaneously to creating economic opportunities, reducing poverty and safeguarding planetary health.

Furthermore, the sources of information that are available so far, particularly information concerning sustainable agricultural policies in developing countries, is limited and often scattered. The development in the near future of additional and more comprehensive databases and data platforms would be extremely valuable.

These databases and data platforms are fundamental, given the importance of the rural sector, and agriculture in particular, in many economies, and the need to focus recovery resources in this sector.

As donors and development partners adapt their programming to explicitly address pandemic recovery needs, it is likely that project monitoring and evaluation efforts will generate more evidence that may be incorporated into green recovery evaluations that can support policy makers in making optimal use of resources.

Table 1 - Databases on COVID-19 recovery efforts

Name	Description	Environmental aspects?	Developing economies?
Energy Policy Tracker	https://www.energypolicytracker.org/ This database tracks how publicly available information on public spending commitments maps onto different types of energy, and other policies supporting energy production and consumption. The database covers more than 30 major economies, as well as the multilateral development banks.	Yes	Yes
Global Recovery Observatory	https://recovery.smithschool.ox.ac.uk/tracking/ This database from Oxford University tracks and individual COVID-19 related fiscal spending policies as declared by 50 leading economies, and includes evaluations of their potential environmental, social and economic impacts.	Yes	Yes
Green Recovery Tracker	https://www.greenrecoverytracker.org/ This database assesses the contributions the national recovery plans of European Union member states make to a 'green transition'.	Yes	No
Greenness of Stimulus Index	https://www.vivideconomics.com/casestudy/greennessfor-stimulus-index/ This database from Vivid Economics covers the G20 economies and 10 others.	Yes	Yes
IMF Policy Tracker	https://www.imf.org/en/Topics/imf-and-covid19/PolicyResponses-to-COVID-19 This policy tracker summarizes the key economic responses governments are taking (as announced commitments) to limit the health and economic impacts of the COVID-19 pandemic. The database covers 197 economies.	Limited Information	Yes
OECD Green Recovery Database	https://www.oecd.org/coronavirus/en/themes/greenrecovery The database tracks the COVID-19 recovery measures that are likely to have environmental implications in 43 countries: the 37 OECD members, along with Costa Rica, Brazil, China, India, Indonesia and South Africa. Coverage of developing economies is limited.	Yes	Very few
Global database on social protection responses to COVID-19	https://socialprotection.org/discover/publications/socialprotection-and-jobs-responses-covid-19-real-timereview-country This 'living paper' from the World Bank tracks social protection measures planned or implemented by national governments. The data are only accessible through the PDF report and appendices. Full title: Social Protection and Jobs Responses to COVID-19: A Real-Time Review of Country Measures.	No	Yes

4. Summary of policy recommendations

The policy recommendations outlined in this report are summarized in Table 2. These recommendations have been organized into three groups.

*First, **climate-adaptive social protection for the rural poor** (pp 16-17) involves aligning CSA advisory and extension services with social protection measures. These efforts directly capitalize on the need to address the welfare impacts of the pandemic on rural populations living in poverty.*

Combining these efforts with targeted extension activities will increase the capacity of low-income farmers to make investments in climate smart practices and other promoted practices of proven value.

*Second, policies that strengthen **enabling conditions for climate-smart agricultural transformation** (pp. 18-20) will help ensure that the broader agrifood system is both conducive to climate-smart production, and that the related market opportunities can sustain these innovations at scale. These measures include trade policies to increase market resilience; capacity building in risk management; the expansion of financial markets and related agfintech services; and policies and investments in institutions that foster innovation across value chains.*

*Third, support for **other green investments** in the broader rural economy (pp. 20-22) will further ensure that agriculture as an economic sector has a more positive environmental profile, with reduced emissions and other environmental externalities associated with production.*

Investment areas include the design of policy incentives to increase the use of alternative energy sources throughout agricultural value chains and the transportation markets that they rely on; providing incentives to support innovations in supply chain management; promoting the development of markets for the recycling of organic waste; and building more efficient value chains with lower rates of food loss and waste.

These recommendations are in line with earlier policy recommendations for CSA in pre-pandemic contexts. For example, all the recommendations are consistent the five action points that have been defined for CSA: expanding the evidence base for CSA; supporting enabling policy frameworks; strengthening local and national institutions; enhancing financing options; and implementation of CSA practices on the field (FAO, 2016; 2021).

In this report, the particular framing of these recommendations as part of pandemic recovery efforts does not imply a major reorientation away from climate-smart strategies. Instead, as has been articulated in Section 2.4, this investment orientation responds to both immediate recovery needs and longer-term climate-smart objectives.

Table 2 - Summary of policy recommendations for supporting a green recovery in developing countries

Climate-adaptive social protection for the rural poor	**Enabling conditions for climate-smart agricultural transformation**	**Supporting other green investments in the broader rural economy**
Combine CSA promotion with social protection	Invest in more resilient agrifood systems	Promote the adoption and extension of alternative energy in agricultural value chains
Invest in opportunities linked with the expansion of digital advisory services	Promote the development of complementary financial markets	Support innovations in supply chain management
Invest in expanding the evidence base on what works and where	Support innovation in agrifood systems sector	Invest in a circular economy for the recycling of agricultural waste
	Support the ability of the private to respond to green opportunities Promote training on CSA	Reduce food loss and waste across value chains

5. Conclusions

The COVID-19 pandemic has created enormous challenges for the stability of agrifood systems and the welfare of households that are actively engaged in the different components of these systems, particularly in developing countries. The efforts now underway to redress the negative impacts of the pandemic through investments to 'build back better' represent an enormous opportunity to make significant and lasting impacts on the longer-term resilience and sustainability of agrifood systems in the context of climate change.

The benefits of these efforts will accrue most directly to rural producers, who make up the largest share of the world's population that is living in poverty. However, these investments will also contribute to longer-term welfare gains for non-rural people, as co-beneficiaries of a stronger global agrifood system, as consumers, and as downstream value chain actors.

More agile and responsive agrifood systems will create new employment opportunities along the rural-urban continuum, and generate fewer negative environmental externalities which will benefit rural and urban populations alike.

The objective of this report has been to give an overview of the opportunities that exist to harness short-term response and recovery efforts to achieve longer-term impacts on resilience and sustainability. Focus has been placed on the role of CSA in these strategies.

Concrete policy options have been outlined that can be implemented by national governments and their development partners. These options are consistent with the policy-oriented scientific literature, and thus reflect the consensus about broad policy priorities. However, it is important to acknowledge that the specific ways in which these policies may be implemented locally may vary considerably depending on different contexts. One size will not fit all for every local set of circumstances, or even at the national level.

The CSA approach is a key component of these policies due to its adaptability to specific contexts. Decision-makers must evaluate tradeoffs between alternative strategies and implement policies that make most sense in the areas where they are to be applied.

These caveats notwithstanding, the overview provided by this report may help guide further discussion of how to respond to this unique moment in history, with a view not just to a short-term recovery from the pandemic, but to address shared longer-term commitments to a healthier planet and a resilient global network of agrifood systems for future generations.

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