

## Climate Change and Food Security: Understanding Vulnerability and Reducing Impacts\*\*

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### Summary

Food security — the ability to obtain and use sufficient amounts of safe and nutritious food — is a fundamental human need, and achieving food security for all is a widely agreed upon international objective. There has been significant improvement in food security during recent decades, but approximately 11% of the global population continues to suffer from persistent undernutrition and hunger. Human-induced climate change poses a substantial emerging threat to further progress. Measures to decrease the rate and magnitude of climate change and increase the adaptive capacity and resilience of global food systems hold promise for reducing vulnerability and negative impacts. Targeted research and experimentation is critical for the development of effective adaptation strategies.

### Current realities

The Sustainable Development Goals adopted by the United Nations in September 2015 call for ending hunger by 2030, and there are reasons to be optimistic about this ambitious goal. The Food and Agricultural Organization (FAO) estimates that the total number of undernourished people worldwide has been reduced by approximately 200 million since 1990-92. The total number of people on Earth increased from about 5.3 billion to over 7 billion during this period, but the proportion of the global population that is undernourished fell from about 19% to about 11%. More specifically, the proportion fell from 24% to 12% in Asia, 15% to 5.5% in Latin America and the Caribbean, 16% to 14% in Oceania, and 28% to 20% in Africa.

Achieving food security, however, remains a major challenge. Despite the decreases listed above, the FAO estimates that there are still 800 million undernourished people worldwide. About 15 million of these people are in the developed world; 512 million are in Asia; 34 million are in Latin America and the Caribbean; 1.4 million are in Oceania; and 233 million in Africa, where the number of those undernourished has actually increased since 1990-92 even though the proportion percentage has decreased. A number of factors threaten future progress. Global population is projected to grow by another 2 billion by 2050. Growing affluence is reducing poverty, but also driving increased consumption and, in particular, increased consumption of resource-intensive animal protein. Large amounts of food — 30% to 50% of total global production by mass — are wasted rather than consumed, partly because many regions lack adequate infrastructure for processing, storage, and distribution. Global food production will have to grow by about 70% by 2050 to meet projected future demand.

Climate change must now be added to the list of food security challenges. There is very strong evidence suggesting that greenhouse gas emissions from human activities are causing changes in global climate. Some of these changes will continue for decades to come, regardless of mitigation actions, because of emissions that have already occurred. Global average temperature is projected to increase by another 1 to 2 °C by 2050 and by 1 to 4 °C by 2100, depending on the amount of future emissions, leading to changes in precipitation timing and intensity, altered stream and river flows, and rising sea levels.

These changes are very likely to have negative effects on agricultural production and other parts of global food systems, including processing, packaging, transportation, storage, and consumption. They are likely to increase the difficulty of minimizing food waste and lead to increased food prices and diminished food safety. The risks are greatest for the global poor and

in tropical and subtropical regions because the poor have limited adaptive capacity, and because tropical and subtropical climates are already close to temperature thresholds beyond which production of many crops decreases rapidly or becomes impossible. Wealthy populations and temperate regions that are not close to limiting thresholds are less at risk. Some temperate regions, including parts of the United States, may actually experience increases in yields of some crops over the next few decades due to high adaptive capacity, and stimulation of plant growth from increased concentrations of carbon dioxide. However, damaging outcomes become increasingly likely in most places from 2050 to 2100 under higher emissions scenarios that lead to large increases in average temperatures, changes in precipitation patterns, and an increased incidence of extreme conditions like heat waves and droughts.

The effects of climate change on food security will be coupled with influences from other large-scale changes over the coming century. Worst-case projections based on high atmospheric concentrations of greenhouse gases, high levels of climate change, high population growth, and low economic growth imply that the number of people at risk of undernourishment would increase by as much as 175 million above today's level by 2080. The same socioeconomic conditions with much smaller increases in greenhouse gas concentrations and smaller climate changes result in up to 60 million additional people at risk. Projections based on scenarios with lower population growth and higher economic growth result in large reductions in the number of food insecure people compared to today, even when climate change is included, but higher emissions of greenhouse gases still result in more food insecurity than lower emissions.

### **Scientific opportunities and challenges**

The degree to which climate change occurs and the capacity of humanity to respond will both be influenced by future socioeconomic development. Technological developments and changes in energy production are very likely to affect future greenhouse gas emissions as well as the rate and magnitude of future climate change. Increasing global wealth and population are very likely to affect future adaptive capacity. From 1950 to today, global population increased from about 2.5 billion to over 7 billion, and global gross domestic product (GDP) increased from about \$5.3 trillion to \$77.6 trillion. Looking ahead to 2050, estimates of global population range from about 8.5 billion to 10 billion, and estimates of global GDP range from \$177 trillion to \$361 trillion. Unfortunately, we lack the ability to determine which of these estimates is most likely, but it is possible to identify alternative future pathways of societal change that are internally consistent (i.e., sets of changes that could plausibly occur together). Systematic comparison of a range of possible future societies with a range of possible future climate changes is needed to provide a more complete picture of future vulnerability and potential future impacts.

The agricultural sector has demonstrated strong innovation and adaptive capacity over the last century, much of which has been driven by scientific advancement, but recent declines in yield increases for some crops raise questions about future adaptive capacity. Additional research is needed to more fully address questions of the potential for further productivity increases across a range of likely future climate changes, the rate of innovation and its contributions to stay ahead of the impact of climate change, and the management practices and infrastructure used across global food systems that offer the greatest potential benefits.

Estimates of climate change impacts are produced by combining results from many different models of Earth systems, the economy, and crops. Each type of model has its own uncertainties, and the combination of multiple models can multiply uncertainty in the results. These modeling systems produce highly aggregated results, which are then used for statistical calculation of numbers of people at risk of hunger or childhood malnutrition rates. As noted above, the complex mixture of socioeconomic changes in scenarios used to drive model experiments have large influences on results. More detailed data and models, increased systematic investigation of the influences of and feedbacks among different variables, and

additional inter-comparison of models and results are needed to more fully assess the potential effects of climate change on food security at subnational, local, and household levels.

### **Policy issues**

The complexity of the food system makes it difficult to understand vulnerability, but it also offers multiple potential points of intervention. There is evidence that continued adaptation of global food systems has great potential to minimize negative impacts from climate change. However, effective adaptation is subject to highly localized conditions and socioeconomic factors, and the technical feasibility of an adaptive intervention is not necessarily a guarantee of its application if it is unaffordable or does not provide benefits within a relatively short time frame. Research and experimentation to accurately identify needs and vulnerabilities, as well as effective targeting of adaptive practices and technologies, are central to improving global food security in the face of future climate change.

- Research on increasing the ability of key crops to tolerate temperature and water stress (through both “conventional” breeding and genetic modification) and further development and evaluation of alternative management practices holds promise of reducing climate change impacts on agricultural production. Relevant actors include funding agencies such as the United States Department of Agriculture (USDA), foundations, and the research community.
- More effective transfer of advanced methods and practices to “high-risk, low-yield” regions and populations (mainly found in Africa and Asia) can improve the efficiency, productivity, and resiliency of global food systems, reduce the risks of climate change, and accelerate progress towards universal food security. Relevant actors include funding agencies, international agencies like the FAO, foundations, non-governmental organizations (NGOs), agribusinesses, and development agencies like U.S. Agency for International Development (USAID).
- Adaptation strategies should be extended beyond agricultural production to other elements of global food systems. Examples include improved packaging and storage methods and deployment of such methods where they are currently lacking, which could keep food safer for longer where refrigeration is absent and food availability is transient; as well as minimizing trade restrictions, which could help reduce cost increases associated with climate change and maintain food availability in the face of regional production difficulties. Relevant actors include policy decision-makers, funding agencies, international agencies, foundations, NGOs, agribusinesses, development agencies, and the research community (e.g., USAID).

### **References**

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