Fighting Hunger in a Changing Climate: How Can Agriculture Respond?

Recommendations for the UNFCCC Delegates in Durban from Leading Scientists in the BRICS Countries, Indonesia, and the United States

DECEMBER 2011

Climate change is a major threat to sustainable food security. Temperatures are rising, precipitation patterns are changing, and extreme weather events are occurring more frequently. As a result, producing enough to feed a growing population is becoming more challenging. Everyone in the agriculture sector must adapt—and quickly. Delays now will raise the costs in the future.

While general trends are clear—for example, a northward shift in the production of rice and maize in the northern hemisphere—major uncertainties remain in the distribution and magnitude of climate change outcomes. What are the location-specific consequences? What are the best techniques for farmers to grow their crops in an environment that could be either wetter or drier; a rainy season that could be either earlier or later; or on lands with the possibility of either flooding or droughts? What is the potential role for agriculture in reducing the amount of greenhouse gases in the atmosphere? At a November 2011 conference in Beijing, leading scientists from around the world gathered to present new research that helps answer these questions.

At the International Conference on Climate Change and Food Security, organized by the Chinese Academy of Agricultural Sciences and the International Food Policy Research Institute, scientists from the BRICS countries (Brazil, Russia, India, China, and South Africa) plus Indonesia and the United States reported results on the food security and climate change challenges facing their countries. Based on the research and data needs identified in their reports, the authors recommend that the negotiators at the 17th Conference of Parties (COP 17) to the United Nations Framework Convention on Climate Change (UNFCCC) hosted in Durban, South Africa, establish a work program that includes (a) strengthening public sector agricultural research in 12 priority areas and (b) increasing the amount, appropriateness, and accessibility of spatial data.

STRENGTHEN AGRICULTURE RESEARCH

Public sector agricultural research expenditures will need to increase substantially to address the needs of agricultural adaptation and mitigation. While the exact amounts needed and the nature of the research to be funded have yet to be determined, the authors identify research in the following 12 areas as a high priority.

Pests and Diseases

Higher temperatures and heightened humidity increase the prevalence of pests and diseases, and it is possible that the temperature ranges that promote this growth will expand. But the ecologies of even the insects and diseases that pose the greatest threats to crop and livestock production are poorly understood. Research findings on how climate changes influence major pests and diseases will help scientists identify the opportunities for reducing their negative effects on agricultural productivity.

Soil Ecosystems

Healthy soils are complex and poorly understood ecosystems that contribute to crop productivity. Research on how these ecosystems can remain strong even when confronted with higher temperatures and more varied precipitation is essential.

Ruminant Agriculture

"Ruminant agriculture" refers to the combination of animals, pastures, and processes necessary to produce meat and milk. It contributes to greenhouse gas (GHG) emissions, and since it is largely a smallholder activity in many developing countries, these emissions are likely to grow as rising incomes in those countries increase the demand for meat. Research on ruminant agriculture in developing countries can identify ways to improve incomes for smallholder farmers and reduce GHG emissions.

Irrigation Structure and Efficiency

Global warming increases evaporation and, subsequently, causes more precipitation on average. A changing climate will likely result in altered distribution of that precipitation and increase the amount of rainfall in extreme events. In addition, a growing population with higher incomes will increase nonagricultural demand for water, so improved irrigation efficiency and more water storage are essential. Research is needed to determine where storage facilities should be built, what systems and technologies are needed, and what areas will provide the highest-efficiency returns to irrigation investment.

Perennial Crops

Perennial crops have several potential advantages, including carbon sequestration and resilience under a variety of stresses. They also present the potential for synergies with annual crops. Research can help to better quantify these benefits at individual sites and explore the potential for cost-effective expansion.

Grain Quality

Controlled research studies and trends of the late twentieth century point to an overall reduction in grain quality (in particular, its protein content) in the face of increasing atmospheric carbon dioxide, especially where nitrogen is limited. More research is needed to better understand these vital relationships across crops and climate zones.

For further reading, please see the conference papers on the International Conference on Climate Change and Food Security website: http://icccfs.ifpri.info.

Storage to Reduce Losses

Food losses caused by poor storage capacity and losses along the supply chain are estimated to be as high as 40 percent in some places, with climate change contributing to even greater losses. To identify the most cost-effective ways to reduce these losses, we need to improve the knowledge base.

Biotechnology

Farmers have long been modifying the crops they grow and the animals they raise by selecting seed varieties and breeds with desirable traits. New techniques make it possible for the selection process to advance faster and for plants and animals with more desirable characteristics to be developed. It is only recently that any of these methods have been used to deal with the new threats from climate change. A better understanding of the most promising approaches is therefore especially important.

Land Use

Land use change is a major contributor of GHG emissions. The conversion of forest and savannah areas—which store large amounts of carbon in the soil—into land used for agriculture—which stores less carbon—must be reduced. But our understanding of the drivers of these changes is still limited and opportunities for reducing undesirable change unclear, in part because of limited data. The economic potential to increase soil carbon storage, and thereby contribute both to mitigation and agricultural productivity, needs more research attention.

International Trade

Research results presented in Beijing and elsewhere show that relatively open trade in agricultural commodities can make an important contribution to climate change adaptation because as climate change increases the variability in production worldwide, trade flows can at least partially compensate. But the magnitude of those benefits and the gains achieved from policy changes that make agricultural trade more open require further research.

Intellectual Property

Groundbreaking research findings are pivotal in equipping farmers with seeds, animals, inputs, and management systems that can respond to climate change. However, this research is only useful once it is translated into actual products and practices. Dealing with the challenges of climate change will require scientific and management breakthroughs to quickly evolve into tangible techniques in the field. Research on how to improve the capacity of current institutions to manage technology development and dissemination can facilitate agricultural productivity growth despite the effects of climate change.

Human Capital Development

Supporting public sector agricultural research and extension capacity means investing in infrastructure (including buildings, lab benches, and experimental fields) and people (including researchers and extension workers). These investments languished toward the end of the twentieth century; a renewed commitment that involves careful consideration of exactly how to best develop agricultural research and extension skills is essential. In addition, both the current and next generations of farmers need ongoing training in technology and communications to ensure rapid response to climate-related challenges.

INCREASE AVAILABILITY OF SPATIAL DATA

Agriculture is inherently a location-specific activity. Weather, soil, market access, prices, and opportunities are crucial factors in farmers' decisions and vary across the landscape, as do government programs and policies and their impacts. To realistically address the effects of climate change on agriculture, we need highly tailored information targeted to particular areas. This means an understanding of circumstances at the state, province, or county level or below. Yet spatially explicit data that document these changes over time are seldom available. This must change. Cost-effective collection of spatial data involving regular observations using standard protocols must be scaled up; the resulting data must be freely and widely disseminated. This will require remote sensing equipment that is more cost-effectively designed and operated, crowd-sourced data that is collected and integrated with official statistics, and improved tools that provide easy access to data in a variety of formats.

CONCLUSION

The authors recommend the UNFCCC delegates in Durban establish a work program on agriculture that can catalyze the research described above. The work program would provide a necessary venue for the agriculture research community to report its findings on climate change adaptation methods. While the benefits are obviously far-reaching, they will most improve the lives of those with the heaviest dependence on agriculture for income: the rural poor in developing countries. With so much at stake and an ever-changing climate, the time to act is now.

Roger Beachy, Donald Danforth Plant Science Center, St. Louis, Missouri, United States; **Kevin Chen,** International Food Policy Research Institute (IFPRI), Beijing; **Elisio Contini,** Brazilian Agricultural Research Corporation (EMBRAPA), Brazil; **Sikhalazo Dube**, Agricultural Research Council, South Africa; **David Gustafson**, Monsanto, St. Louis, Missouri, United States; **Jarot Indarto**, National Development Planning Agency (BAPPENAS), Indonesia; **PK Joshi**, IFPRI, New Delhi; **Sergey Kiselev**, Lomonosov Moscow State University (MSU), Russian Federation; **Geraldo Martha**, EMBRAPA, Brazil; **Endah Murniningtyas**, BAPPENAS, Indonesia; **Gerald Nelson**, IFPRI, Washington, DC; **Roman Romashkin**, MSU, Russian Federation; **Nono Rusono**, BAPPENAS, Indonesia; **Bob Scholes**, Council for Scientific and Industrial Research, South Africa; **Setyawati**, BAPPENAS, Indonesia; **Deepak Shah**, Gokhle Institute of Political Economy, India; **Eugene Takle**, Iowa State University, United States; **Huajun Tang**, Chinese Academy of Agricultural Sciences (CAAS), China; and **Liming Ye**, CAAS, China.