

CIMMYT

Climate Change



Concerns

Climate change and increasing climatic variability have raised widespread concern, although the implications of these trends are not well understood. Even so, it is already possible to envision some of the difficulties that could arise for agriculture, such as a greater incidence and intensity of drought and high temperatures (e.g., in many areas of sub-Saharan Africa) and a greater risk of flooding (e.g., in Asia, especially the Indo-Gangetic Plains). The challenge of dealing with climate change and increased climatic variability is intensified by:

- insufficient information on how climate trends will affect the suitability of specific crops and cropping practices in specific areas;
- insufficient information on how climate trends will affect the incidence and evolution of diseases and pests in specific areas;
- a lack of appropriate crop varieties and agronomic practices for more variable and more risky agriculture;
- the continuing growth in demand for food in developing countries, driven by population increase and, to a lesser extent, income growth; and
- a declining natural resource base, in which soil fertility is increasingly depleted and water is becoming scarce.



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These circumstances are far more serious than anything the world has seen in the past 30 years. Some regions of the world will be affected far more than others. The tropics and subtropics, where CIMMYT focuses the largest share of its research resources, will be most vulnerable to climate change and increased climatic variability. Unless CIMMYT and other institutions act now to build on their expertise with new tools, new methods, and new research partnerships, hundreds of millions of already disadvantaged people will suffer the consequences. The regions that have benefited from progress in agriculture to improve living standards and education could be set back by more than a generation.

Responses

No single research institution possesses the capacity to cope with problems of this scope. In research alliances directed at understanding, mitigating, and ameliorating the effects of climate change and increased agroclimatic variability, CIMMYT can offer information, expertise, and research products. Some specific examples follow.

The Importance of Information

For more than three decades, CIMMYT has accumulated crop performance information on maize and wheat in more than 100 countries in the developing world. Using the tools of GIS and modeling, it is possible to combine these data with data on the incidence of biotic and abiotic stresses in important environments in the developing world and to assess how climate change and climatic variability have affected maize and wheat and the agroecosystems where they are grown. A better understanding of trends over the past 30 years could prove invaluable in

attempts to predict the effects of climate change and variability. Researchers urgently require information systems to help set more precise research priorities for coping with climate change and variability in specific environments. Information and expertise available at CIMMYT can contribute a great deal toward the development of such systems and increase the likelihood that appropriate technologies and sustainable production systems will become available for developing countries.

Maize and Wheat for Changing Environments

CIMMYT and its partner institutions form an international research network that has considerable experience in developing maize and wheat varieties for developing countries. Agriculture in developing nations is already subject to biotic and abiotic stresses that in many cases are more intense than those experienced elsewhere in the world. The participation of this international research network will be crucial to resolving problems related to climate change and climatic variability. Undoubtedly research in developing countries will also produce valuable alternatives for industrialized countries whose agriculture is at risk.

Drought and other abiotic stresses: CIMMYT has made a long-term investment in research focused on enabling maize and wheat plants to tolerate extreme abiotic stresses such as drought, heat, and waterlogging. The Center is also amassing expertise in using the techniques of applied biotechnology to support these breeding objectives. Progress to date is encouraging:

- Under farmer-managed conditions where grain yields typically average only 1.3 tons per hectare, outstanding experimental open-pollinated maize varieties and hybrids from

CIMMYT give farmers 30-50% more grain per hectare than the best commercially available maize.

- New wheats produce up to 30% more grain when grown using only a single irrigation that supplies 120 millimeters of water. (An additional 50 millimeters are probably available from the atmosphere and soil.)
- These maize and wheat varieties also yield well when rainfall is good, as happens occasionally in some dry environments.

As the globe becomes warmer, the need for these research products will become more acute. New research partnerships to speed their development and diffusion to farmers are critical.

Other challenges to maize and wheat improvement will be found in highland ecologies (such as the Central highlands of Mexico and the Andean highlands). As these environments become warmer, the highland varieties that evolved over thousands of years to cope with cold conditions cannot adapt. To avoid losing their livelihoods, farmers need maize and wheat varieties that survive heat stress. In other areas that are now subject to greater flooding or more intense rainfall, farmers will need plants that survive very wet, waterlogged conditions.

Diseases and other biotic stresses: Farmers' livelihoods and food security in developing countries are threatened by biological as well as environmental changes. As subtropical climates become warmer, agriculture is experiencing new and more serious biotic stresses that are typically tropical, such as rust diseases, maydis blight, corn borers, and armyworms. Simulations suggest that a temperature increase of 2–4°C in the tropics and subtropics will considerably increase the losses to insect pests that consume stored grain. Maize and wheat that resist tropical

and subtropical diseases and insects will become even more important as conditions become more difficult.

The role of biotechnology: As noted, biotechnology research at CIMMYT is integral to efforts to develop maize and wheat with superior stress tolerance. Progress in marker-assisted selection, molecular mapping for drought tolerance and disease resistance, and the recent identification of wheat lines with an extremely high transformation rate should all help breeding programs deal with the problems of climate change more rapidly, efficiently, and cheaply.

Cropping Practices to Cope with and Limit Climate Change

New crop varieties can help farmers *adapt* to the effects of climate change, but new cropping practices hold great potential for *alleviating* some of the causes of climate change. Conservation tillage, for example, sequesters carbon from the atmospheric pool and mitigates global warming. Much research by CIMMYT and its partners has focused on this important topic in maize and wheat cropping systems, and the rapid adoption of zero-tillage in the rice-wheat systems of South Asia's Indo-Gangetic Plains is an exciting recent development. In rice-wheat systems, tillage is the main source of carbon dioxide, a greenhouse gas. Zero tillage does away with intensive and repeated plowing of farmers' fields, increases harvests, and reduces water use. At the same time, it reduces carbon dioxide emissions by an estimated one-fourth of a ton per hectare. If zero tillage were adopted on 5 million hectares—less than half of the rice-wheat area in the Indo-Gangetic Plains—carbon dioxide emissions would fall by an estimated 1.3 million tons per

year. If farmers stop burning crop residues and reduce the frequency of flood irrigation in rice, major additional reductions in greenhouse gas emissions will occur. The growing use of zero tillage in this highly populated, intensively cropped area, where poverty and agricultural resource degradation are endemic, indicates the growing importance of fostering ecologically and economically sustainable farming alternatives.



Other research by CIMMYT and its partners is examining the rate, timing, placement, and type of nitrogenous fertilizer in wheat production. Researchers have identified appropriate technologies that considerably reduce the emission of nitrous oxide and nitric oxide. One challenge will be to transmit this and other new crop management knowledge to the intensively cropped areas of the developing world, such as South Asia, which are critical to the food security of millions of people. Yet another challenge will be to develop new, appropriate management strategies for many marginal, already vulnerable farming areas (for example, in Africa).



Finally, in some areas, climate change may reduce the growing seasons for maize and wheat altogether. Farmers will require cropping practices that enable varieties to make the most of shorter growing seasons, as well as varieties that mature more rapidly without sacrificing yields.

October 2001

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