ICRISAT
Science with a human face

December 2009

Adapting to Climate Change: Hypothesis of Hope

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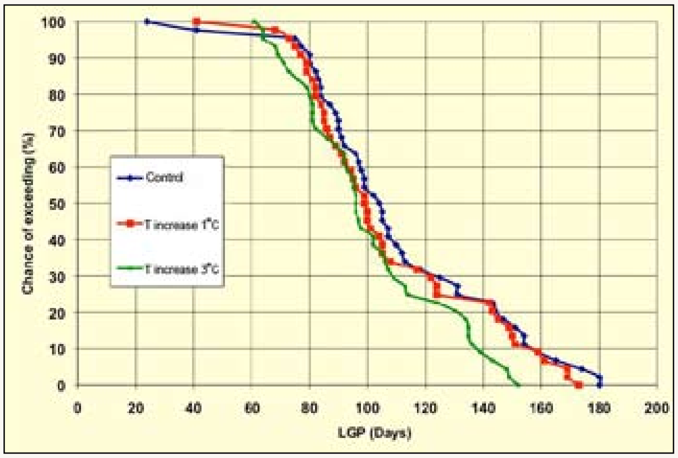
We live in a warming world. How bad will it get? We can't say for sure, but it seems clear that the dryland poor will be especially hard-hit. The Intergovernmental Panel on Climate Change (IPCC) concluded in its most recent assessment that *"At lower latitudes, especially in seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger.*

But even the highly sophisticated models that are cited by the IPCC are uncertain, predicting a range of possible temperature and rainfall trends. Furthermore, the scales at which these models operate — global and regional — are too imprecise to help people whose livelihoods are determined at the level of the field, farm and district. How can farmers adapt to a future that is so fuzzy?

Navigating uncertain waters

Rather than betting the future on one uncertain prediction or another, ICRISAT scientists decided to sample across a range of possible futures and draw lessons from broad response patterns, comparing them against the variation in temperature and rainfall that already occurs over years in strategic locations across Africa and India. This in-depth analysis was based on the painstaking collection of many thousands of meteorological station measurements by different institutions over the past 30-50 years.

How could such large and complex data sets be handled? Scientists drew on the power of computer-based climatic and crop production models, built through decades of intensive laboratory and field work by a wide range of institutions.



Time to grow

The models, known by the acronyms APSIM and DSSAT, found that one of the most important effects of rising temperatures would be to increase the rate of evaporation of water from soils and crops, shortening the length of the growing period (LGP). For example, the mid-point of the curves in the figure illustrate that under average rainfall conditions in Makindu, Kenya (50% probability point on the vertical axis) a 3° rise in temperature would be expected to cause a reduction in LGP of 8%, shortening average

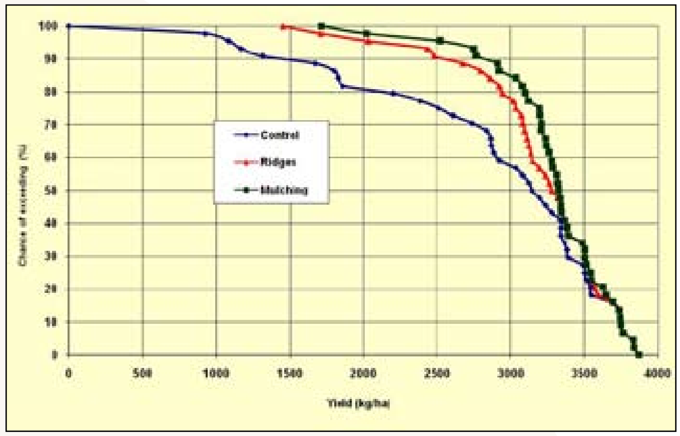
LGP from 108 to 101 days. Shorter LGP results in lower grain yield, because the crop has less time to convert sunlight into carbohydrate.

What is especially striking and noteworthy, though is that this 8% reduction pales in comparison to the variation in LGP that farmers *already* experience due to the wide variation that occurs in rainfall from season to season (blue line), causing LGP to vary from well under 80 days to more than 130 days.

The key message of hope that this finding delivers is that **the study of how farming systems cope with *current* rainfall variation is likely to yield important clues for adapting to *future* climate change.**

What are those adaptations, though and how can they be harnessed for the future?

Managing moisture



Since warming will dry out soils more quickly, two strategies to increase soil water storage were modeled using APSIM under Makindu conditions. The practices were i) planting a maize crop on soil formed into ridges across the slope to reduce the runoff of rainfall water, and ii) leaving residues from the previous crop on the soil surface to reduce runoff and evaporation (mulching). The model predicts that these two **water management techniques would remarkably improve and stabilize yields** relative to the wide climatic variation experienced over the past 50 years (red and green lines in the graph). In fact, further model analyses (not shown here) indicate that even with a 3° temperature rise, mulching would **effectively extend LGP** *beyond* the current average of 108 days, to 113 days at this typical location.

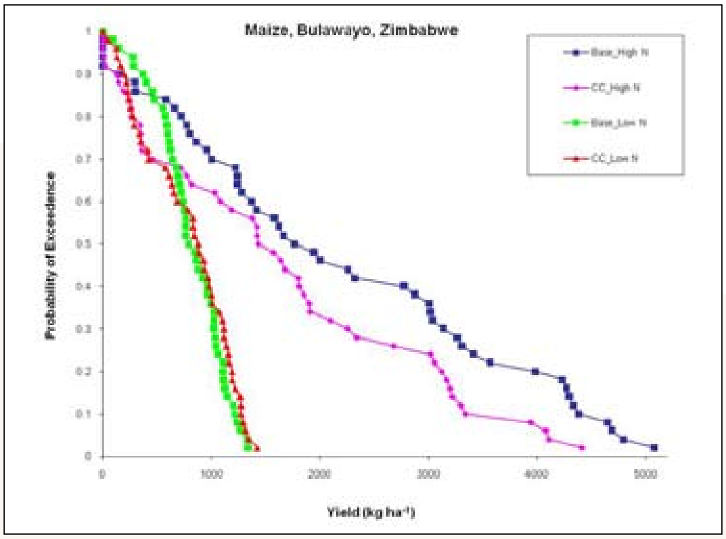
Exploiting evolution

Even when water losses are countered, another problem arises. Higher temperatures accelerate the development of plants, causing them to mature too quickly before they've fully utilized available water and sunlight to produce grain.

Fortunately, though crops have evolved wide genetic variation in their inherent 'development clocks'. Based on our germplasm and breeding research combined with model predictions, we are confident that **sustained effort will identify varieties whose development cycles are well-matched to the warmer temperatures that farmers will face.** However, extreme temperatures can still cause considerable damage at sensitive growth stages; the search for resistance genes needs to be intensified.

Quick-developing (background) vs. slow-developing millet varieties, Niamey, Niger.

Climate change in comparison to nutrient-depleted soils



As serious as it is, climate change is just one of a host of challenges that will reduce grain yields for smallholder dryland farmers of the future. For example, this graph indicates that the impact of a 3° temperature increase on maize yield is likely to be relatively small compared to the impact of continuing low rates of application of nitrogen fertilizers (compare the small distance within each pair of lines, versus the large distance between the two pairs of lines). This suggests yet another strategy for countering climate change: **redouble our efforts to make fertilizer more readily available to farmers.**

Looking ahead

These hints of hope illustrate how modern science can cut through the fog of uncertainty, complexity and pessimism on a crucial global issue. **Strategic, longer-term research of this type must be strengthened.** Models must be continually improved. The effects of heat on many different farming system dynamics must be better understood. Precious genetic diversity must be vigorously collected, conserved and characterized. Human capacities must be strengthened in all these areas at national as well as international levels. Conditions for the adoption of adaptive technologies must be fostered.

With your support and partnership, ICRISAT's Hypothesis of Hope will continue to enrich the insights, options, and actions needed to help the poor to beat climate change.

Sincerely yours,

William D. Dar
Director General

About ICRISAT

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The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT is supported by the Consultative Group on International Agricultural Research (CGIAR).

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