Conserving Crop Biodiversity: Navigating Politics and Climate Change to Create a Global System

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Paper prepared for presentation at the "Agriculture in A Changing Climate: The New International Research Frontier" conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, September 3, 2008

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A couple of months ago a journalist from a magazine asked me to name the five most important or influential books in my life. I had to start off with a little book called *Zeek the Rabbit* which hooked me on reading when I was about seven or eight years old, and that left me four more slots. One of those slots I gave to a remarkable book that I keep going back to over and over again. It's a haunting and informative book called *Feeding the Ten Billion* written by an Australian plant physiologist named Lloyd Evans. Lloyd looked at different moments in human history, going all the way back to when the population was five million and then 50 million, 100 million, a billion, 2 billion, and 3 billion. He asked what kind of food system was in place for each of those periods and how the way in which people procured or produced food had changed as the population grew, as the technology changed and as the environment changed. Today, as the population races along towards the nine billion expected in 2050, this is a question that should be examined. Just as important, perhaps, as asking how are we going to feed two and a half billion more people on planet earth, is asking how are we going to deal with an extra two degrees of temperature, or more.

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The challenges for agriculture — and us

Agriculture is facing an unprecedented combination of challenges. Water withdrawals from lakes and waters have doubled since 1960. The overdraft of aquifers is 25% in some places in China; 50% in some places in India. Each aquifer essentially has its own countdown to extinction, and global demand is increasing. Energy consumption now exceeds discoveries — which peaked in 1960 — by a factor of four. Half of the commercial nitrogen fertiliser that has ever been applied to our farms has been applied since 1985 — and nitrogen fertiliser is based on natural gas, which is linked to oil, so we have to question both availability and price. Then there is population growth, the development pressures spoken about by Minister Burke, low stockpiles, and the real killer, chronic under-investment in agriculture research. What a combination! And that's given us high prices that can only get higher unless we smarten up.

Climate change

Let me focus first on climate change. Twelve of the hottest years on record have all occurred since 1990. We have been working with climatologists at Stanford University and University of Washington, and the Bureau of Meteorology in Melbourne, to ask how climate change is going to affect — or should affect —how we manage our collection of crop diversity.

Examples

The graphs in Figure 1 display average temperatures for two countries, Nigeria and Thailand. The bell-shaped curves formed by the blue columns display the average summer temperatures over the last hundred years. The curves formed by the red columns give the projected temperatures for about 2080 onwards as derived from the mean of the different IPCC climate studies.

Note that there is virtually no overlap between current and future temperatures. In historical terms, this means that the hottest growing seasons of the past hundred years or so would in the future become the coldest growing seasons. The conditions that have caused problems lately during hot growing seasons will in the future seem like good years.

Taking a long-term view, present-day agricultural systems and crops have been adapted to specific regions with particular climates since Neolithic times. Many crop varieties, handed down from generation to generation, have been adapted to climates that are about to become extinct themselves. These particular country examples are not exceptional; the shift in climates will likely be significant in most parts of the planet. Of course climate change will be gradual, but the effects are already becoming visible.

If we have the same varieties of corn in the fields in South Africa in 2030 — which is about two crop breeding cycles away — as we do today, the projection is that we will have about a 30% decrease in corn production.

Economists, seeing that we have had a certain increase in production every year in the past, will project that there ought to be a 30% increase in production by 2030.

Instead of the 30% increase, however, there may well be a 30% decrease because of climate change. People will starve to death in southern Africa unless we do something — and do something rather quickly. Two breeding cycles away is really not a terribly long time.

Human settlements of the past

Societies that decide that they can battle the climate and ignore climate change tend to suffer

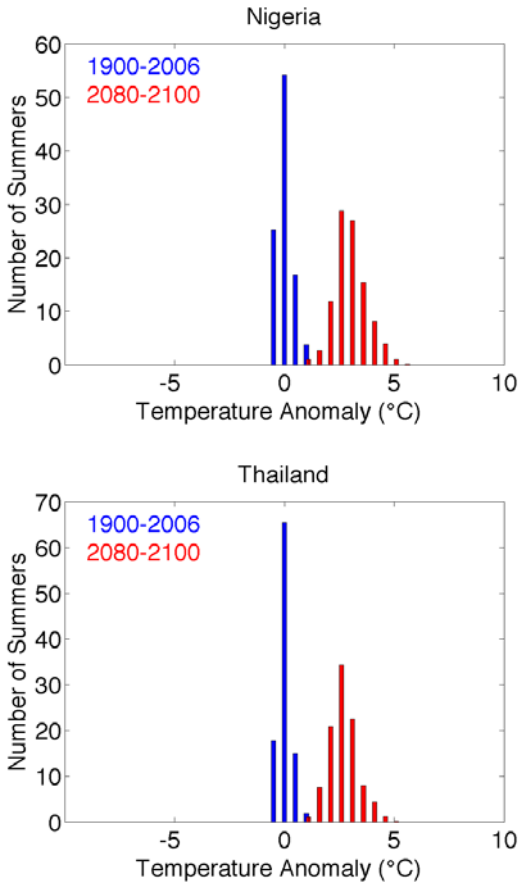

Figure 1. Distributions of (summer) growing season temperature against climate model predictions (Source: Naylor, R. and Battisti, D. 2008, pers. comm.)

the consequence. Figure 2 shows a church built by the Norsemen in Greenland. The last wedding ceremony was performed in this church in 1408. Some time in that century the Norsemen disappeared in Greenland. They disappeared because they didn't want or know how to adapt to climate change; the climate was getting colder and they wanted to continue to raise cattle which didn't do very well in those temperatures. The Inuit did adapt to the change, and are still in Greenland. The Norse now visit as tourists.

Options for feeding the world

Lloyd Evans writes that there are about six ways of increasing production, and that historically the most significant way has been to cut down trees to expand cropland. Globally this is becoming less and less of an option.

But something remarkable has happened since the mid-1980s. For the first time in all the history of agriculture dating back to the Neolithic we have started to produce more food principally by intensifying production through genetics and through inputs rather than through expansion of cropland. The question is whether we can continue to run faster and faster, to keep up or perhaps get ahead. The answer, or at least the key to answering that question, lies in crop diversity.

Figure 2. A church abandoned in Greenland some 600 years ago due to climate change

Genetic diversity is the key

Figure 3 shows just a couple of kinds of beans — they are pretty, but more importantly they have unseen diversity. There are about thirty thousand different varieties of beans, perhaps two hundred thousand varieties of wheat, and even more varieties of rice. These varieties are more than just beautiful, and more than just an historical library of the past of agriculture. They are the result of adaptation — not just to climate change but also to past diseases, droughts and the myriad environmental conditions on the planet.

Figure 3. Great diversity is evident in this sample of beans

There is no more important natural resource on earth for humans than crop diversity. There is also no resource upon which nations and people are more interdependent. This interdependence is worldwide — data indicate that Italy where I now live and Ghana are equally dependent on crops that originated outside those countries. The dependence is at the varietal level and at the pedigree level of our modern crop varieties. Luckily, along with being the most important resource, crop diversity is among the easiest and cheapest to conserve. It's a matter of freezing seeds. Despite the simplicity, though, we have no efficient coordinated global system for conserving this most valuable natural resource.

When a cyclone put about a meter of water and mud into the Philippines National Gene Bank in September 2006, destroying a number of distinct unique crop varieties, a number of varieties became extinct because of the absence of an effective global storage system.

The resources that became extinct that day in the Philippines may be exactly the resources needed

in the future to breed a climate-ready crop in Australia, in Ghana or elsewhere. Now more than ever before we are our brother's keeper. What happens in other countries has to be of concern to us, if nothing else out of self-preservation.

The cost of conserving this diversity is so small and the benefits so incredibly large that not conserving it is really just beyond imagination. So what do we do? We cannot simply talk about the need to adapt to the challenges that lie before us. Short-term thinking has lead to long-term problems that are not going to be corrected by more short-term thinking or short-term approaches.

Investment in conserving, managing and developing crop diversity is going to be an early indication of how serious countries are in meeting the pledges made in the recent food summit to strengthen food security. Crop diversity is going to be the canary in the coal mine because it is the biological pre-requisite for adaptation and improvement.

My dream is that all crop diversity is stored safely and securely in two gene banks as well as at the Svalbard Global Seed Vault, and be freely available without political, legal or practical constraints. I cannot imagine any effective and sustainable solution to climate change or to water problems or energy problems without crop diversity. I invite you to consider that.

The Global Crop Diversity Trust

This is why the Global Crop Diversity Trust was created a few years ago. We are structured as an endowment fund and our mandate is to help create a global system that will conserve unique diversity in a cost-effective manner, not for 49 out of 50 years but for 50 out of 50 years.

The Svalbard Global Seed Vault

Of course every great dream or scheme or plan needs a fallback plan, a plan B, an insurance policy. That is what we have tried to provide in Svalbard, Norway, in a group of islands located far off the northern mainland coast of Norway. To go there you fly to a town called Tromsø in northern Norway and then on another plane fly an hour and a half further north to a location at about 78° north. This is a remarkably beautiful place, unique in the world. There are big glaciers. Of course there's climate change, so there are fissures in the glaciers, which may reach 100 m tall or more. There is also a small Norwegian village called Longyearbyen of about fifteen hundred people that provides excellent infrastructure. It is near this village that we find the Svalbard Global Seed Vault. The Vault was constructed and paid for by the Government of Norway. The entrance is via a tunnel that goes about 130 m inside a hill, where there are three vaults for storing seed. Together they have the capacity to store 4.5 million samples.

We have gone to Svalbard because it is remote. An insurance policy for seeds must survive storms, equipment failures, fires, wars and all the kind of things that sometimes destroy the collections and buildings that we call seed banks.

The location is in fact remote but accessible: remote to give safety, accessible to enable seeds to be moved in and out. And it is cold — naturally cold to avoid dependence on mechanical freezing equipment.

Each of the vault rooms is capable of storing one and a half million seed samples, with about 500 seeds per sample. One and half million is the number of total varieties worldwide we think actually exist. This is a building for the future; it has three times as much space as we think we'll need , and so we don't plan on the facility being full any time soon. We have about 350 000 different varieties of seeds stored there now.

A broader system

The Svalbard Global Seed Vault forms only part of a rational global system for conserving and using crop diversity. Had it been built ten years ago it would probably have been used ten times already to restore seeds to seed banks because the conditions in normal seed banks are so deplorable in so many countries.

We really have to prepare for the storm that is coming. With support from Australian Grains Research and Development Corporation (GRDC) the Trust has mobilised scientists and specialists worldwide to develop crop strategies that identify the most genetically important collections in the world. We know now what remaining diversity needs to be collected. We know how to conserve it, and we have begun to make long-term conservation grants that secure the most important collections — fifteen crops at the moment. We have a competitive grants program for screening the collections for useful traits, and we have another program for rescuing collections that are

in bad shape — principally in developing countries. We think that between 100 000 and 150 000 distinct crop varieties will be rescued in the next couple of years.

We need to develop new information systems. We've given a couple of grants to create an amazon.com or a google.com for plant breeders, so that in the future if you are trying to breed climate-ready crops you can find the genetic resources you need by searching through all the collections around the world rather than just your home gene bank.

Conclusion

We face a major world problem if we don't conserve crop diversity. But we can conserve it — this is a problem we can solve. We don't need recourse to technology that has not yet been invented. The technology we need is something that you have got in your kitchen, it's called a freezer.

We need, however, to build the endowment fund and put together the institutional arrangements to make sure that this diversity is conserved for as long as we think we are going to need agriculture.

In the face of all the different challenges that we have with agriculture now we must choose our goals wisely and make those goals worthy of who we are and who we want to be.

I feel incredibly lucky to work in this field. I've had a charmed and very lucky life. Having worked on the Seed Vault and at the Trust with many wonderful people, I think of the lyrics from an old song:

> … *somewhere over the rainbow skies are blue, and the dreams that you dream really do come true.*

I know that dreams don't come true unless they are shared by a lot of people. So I want to end by saying that the Trust has had enormous critical visionary support from AusAid, from GRDC, from the Crawford Fund, from DAFF — I can't thank you enough.

Last but not least, I want to join the long queue of people recognising an individual here from whom we have had steady and substantial support — Bob Clements.

Thank you all very much.