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Creating global food security: a vision of adapted crops and soils

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Good morning. When Cathy Reade invited me to come Australia to give this keynote address today, I recalled giving the Sir John Crawford Memorial Address in 2015, and I began to ask myself: What's different now from 2015? What has changed? What have I learned in those years and what did I get wrong? What did I overlook? Not surprisingly, I did get a few things wrong, and I did overlook some stuff, and that is what I will talk about today.

One thing that has changed is the number of food-insecure people, which is now 800 million or so. In 2015, I based my lecture on a wonderful book by Lloyd Evans (of CSIRO). The book was called *Feeding the ten billion*. I think it is still one of the best books I have read on the subject. Towards the end of that book Dr Evans outlined that there are only six ways of increasing food supplies, and we all know that food supply is going to have to increase, if only because of population growth.

Land, water, climate

In the 2015 lecture I considered the constraints or obstacles, the challenges towards increasing food supply, and in particular I looked at climate and at land and at water.

- The amount of land devoted to grain production in this world, on a per capita basis, is half what it was in 1961. So that is probably not going to be a way out of our current crisis.
- Most of the aquifers in the world today are in a state of depletion: they are being depleted faster than they are being replenished.

Even though I was really preoccupied by climate in 2015, I don't think that I or, maybe, any of us quite anticipated the speed or the severity of the changes that were ahead: the number and the extent of extreme weather events. This past June was the hottest June ever recorded for global temperatures. July was the hottest July ever recorded. July was the 533rd consecutive month in which the global average temperature for the month – July in this case – exceeded the 20th century average for July. Five hundred and thirty-three consecutive months of 'above average' temperatures! I don't know anything in life that happens 533 consecutive times by coincidence. Something is changing, and it is happening in real time.

We are seeing historic drought in the Horn of Africa. We have had heatwaves and droughts and fires in the United States and Europe. Pakistan has just been through a monsoon that was five times the 30-year average: 2 million acres were flooded and 800,000 animals were killed. And now we're heading into El Niño, and you know what that that means.

Many people are saying, 'Well, you know, this is the new normal'. But maybe not. Maybe the new normal has not quite arrived yet. Maybe the new normal is actually in the future. If you look at climate predictions, you would have to say the new normal is not yet here. In fact, today's weather may turn out to be the coolest and best that our agricultural systems experience in our lifetime.

Although the speed and the severity of climate change has exceeded even my expectations, it is not clear to me that our analysis has caught up with that. I am not sure that our analysis of what to do, or how much to do, has really changed quite as much or quite as fast as the climate itself. And I am not sure that we in the global community have fully come to appreciate how profoundly and how extensively climate change is going to affect our agricultural production.

If you look at crops, you know that excessive heat affects every part of the plant, at every part of the growing season, from roots to flowers. Therefore, in the future, our plant breeders are going to have their work cut out for them in adapting every part of the plant to climate, at every part of the growing season, and they will need to do that for every one of our crops.

Conflict

Looking back at my 2015 lecture, the one big thing I really missed was conflict. I don't think I mentioned it in the 2015 lecture. We know, of course, that there is a strong correlation between climate, food insecurity and national security and conflict. That correlation goes back many years.

In 2007 and 2008, we saw climate events, we saw food-price hikes, we saw unrest in 15 countries in sub-Saharan Africa. If you look back at the 'Arab Spring' in 2010–2011, you'll see it was a time when China was having a drought; food prices were going up. All the countries that are the largest importers of wheat on a per capita basis were in the Middle East, and there was the Arab Spring.

I am not saying that the correlation is total, but I am saying that climate is a threat multiplier for conflict, and conflict is a threat multiplier for insecurity. Of the people on Earth that are food-insecure, 60% live in countries that are experiencing conflict, and 80% of the children on Earth that are stunted or malnourished are living in countries with conflict.

Regarding the invasion of Ukraine by Russia, Ukraine was one of the top five exporters of food in the world. It has historically been a breadbasket for Europe. Ukraine is a top-five exporter of wheat, barley, sunflower and maize, and the whole infrastructure of the country is geared towards exporting that grain through the Black Sea. As you all know, Russia has pulled out of the Black Sea Grain Initiative, but you may not realise that during the time that the Black Sea Grain Initiative was in effect Ukraine exported 32 million metric tonnes through the Black Sea. That is not as much as Ukraine would normally export, but it is a lot of grain. The wheat portion of those 32 million metric tonnes was enough to make 18 billion loaves of bread. It's not trivial. Now, in the last two days, Russia has bombed the Ukrainian ports on the River Danube delta, which is the alternative way Ukraine can export its grain through the Black Sea.

This is a war on food security. Poor people in the global south are the collateral damage for Mr Putin's war in Ukraine. Words fail me to describe the immorality of what is happening.

Trade

Another thing I failed to mention in 2015 was the importance of trade. In a world with many different risks and many different uncertainties, trade becomes much more important. One hundred and thirty-one out of 196 countries on Earth are net food importers, which underlines the importance of trade. I think that as shocks continue to the system, and as they increase, we are going to see trade become much more important. Already we see some countries reacting to climate issues and other production issues by trade restrictions and export bans. India has put bans on exports of wheat and rice, and duties on onions.

To recap, what did I get wrong in 2015; what did I not emphasise enough; what did I overlook? I missed aspects of the effects of climate, and I didn't anticipate conflict, and problems in trade.

All these issues show that we must think more seriously about building resilience into our food systems, ensuring that countries and farmers have viable options. I think resilience is something we certainly need at the national level and, in many places, at the farm level.

New initiatives: understanding soils; using adapted crops

When I joined the State Department, I asked myself: What faulty assumptions are we making? Where and how can we add value, and what can we do that is meaningful in that scale; that has a big impact and that is not easily undone by politics? That led me back to thinking about the basics, about the fundamentals.

It seemed to me that if we are following the Hippocratic Oath – 'first do no harm' – that we must realise that there is no such thing as food security unless you have good soil and you have adapted crops. We cannot have food security based on poor depleted soils and unadapted crops; yet poor soils and unadapted crops are found in many places in Africa. By the end of the century, Africa will be the continent with the biggest population on Earth. Therefore, the State Department has begun to promote 'a vision for adapted crops and soils' (VACS).

For soils, and particularly paying attention to Africa, we think that what is needed is better information, better soil mapping, and better analytics. Those should allow the countries to make more-informed planning decisions about agriculture, and enable farmers to make better management decisions: such as how to fertilise appropriately so that they get the most benefit from the small amounts of fertilisers they are applying. Erosion is taking away soil in Africa right now at a rate that is 100 times the rate of soil replenishment. Obviously, therefore, if we're looking for food security in Africa we should not think of humanitarian aid as being equal to food security, nor can we think about food security without having good healthy soils.

For crops, we have started an initiative that is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO) and by the African Union. It is a three-step program. As background, the African Union a few years ago adopted a common position on food systems, in which they emphasised the importance of traditional and under-utilised and indigenous crops in Africa. They noted that there has been massive under-investment in these crops. In Africa today, the staples are wheat, maize and rice – and these crops all originated outside Africa. Probably no other continent in the developing world is in that situation.

In the three-step program, the State Department is investigating some of the under-utilised crops, both to help them fulfil their potential to increase the resilience of the systems, and also to provide good nutrition for people in Africa.

- The first step, with co-sponsor the African Union, is to identify those crops that have the most potential for adding good nutrition to diets in Africa.
- The second step is to narrow that list – we started with about 300 indigenous African crops – down to the 60 we think have the most potential for boosting nutrition. And the second stage of that is to examine those 60 crops for their likelihood of performing well in a changing climate. If we have that information – that is, if we know which of the crops have the most potential to boost nutrition and which of those are likely to do best despite climate

change, then for the first time in history we have a rational basis for making investments in crop improvement.

Therefore, we have brought together the nutrition community, the climate-change community, and the agricultural development and plant-breeding communities, for the first time in the same room, to discuss these issues and to rethink what a cropping system would look like, based on nutrition, and then to facilitate it via this work on crops and soils.

We believe that diversity of crops equals greater resilience, and that dietary diversity equals better nutrition and less stunting of children in Africa, which is a terrible problem.

- The third step in our program is to establish a multi-donor trust fund. We are in discussions with the International Fund for Agricultural Development, in Rome, about establishing that fund so we can provide ongoing support for these types of efforts. Plant breeding takes a long-term commitment, as you well know.

New initiatives: focus on agricultural R&D

The second big thing that we have tried to push at the US State Department is simply to bring more attention to the need for agricultural research & development.

Agricultural research & development is the comparative advantage that countries like Australia and the United States have in this world. And yet, speaking for the United States, I will say that our public investment in agricultural research on an inflation-adjusted basis is back where it was 50 years ago. In the midst of growing and severe challenges to food security, we need to be prioritising agricultural research & development if we are going to maintain our status in the world and if we are going to promote the kind of values that the United States and Australia share.

To have a chance of creating a food secure world, we must reprioritise agricultural research. 'Business as usual' is not going to be enough. In fact, I think we need to be ambitious and aspirational, and perhaps go for a few 'moon shots', a few big developments in agricultural research & development.

I am not the right person to tell you what those would be, but maybe it could be nitrogen-fixing grains, or maybe perennial grains, or maybe a transition of some C3 grains to C4 for photosynthesis. Maybe it could be work on aflatoxins and mycotoxins to reduce post-harvest loss. There are many different things that we could be putting scientific effort into. These are the kinds of things that we want to do, and I think that we have to adopt a mindset of being willing to make long-term investments and long-term commitments to do those.

Closing thoughts

Finally, two thoughts. One is that I hope everyone in this room appreciates how important and how special the Crawford Fund is, and that it is an amazing institution. There is no institution like it in any other country that I know of. I really wish every country in the world had a Crawford Fund, and I really wish that every country in the world had a Cathy Reade. Unfortunately, there is only one of each.

The second thing I want to mention as a final note is that, as John Anderson has also mentioned, we have lost some real 'giants' in our field in recent years. In 2019, we lost Tim Fischer, who had been the Chair of the Board of the Global Crop Diversity Trust and who was such a friend and such an ally for us.

You in Australia lost John Kerin recently, and in August we in the US lost a couple of other very special people. One was Professor Sir Gordon Conway, who was a former president of the Rockefeller Foundation and who wrote a book called *The doubly green revolution*. And then we lost a person who was one of my dearest friends and a dear friend to several people in the audience, and that was Wally Falcon.

Wally was an agricultural economist, a professor at Stanford University, co-founder of the Center on Food Security and the Environment, and of the Presidential Commission on World Hunger. He was one of the few people (with only one or two others) who have been Chair of the Board of both the International Maize and Wheat Improvement Center (CIMMYT) and the International Rice Research Institute (IRRI).

Wally was a bigger-than-life person on the outside. He looked a bit like Winston Churchill in the face, and he had a gruff exterior, and a deep voice. I was thinking about him as I thought about what to say to you today; and I thought: Well, if Wally were here and if he were out in the audience after I finished my talk, he would come up to me probably, and in that deep voice of his he would say, 'Well, pretty good lecture, Cary'. And then he would say, 'You know, you made some important points there'. And then, with a little twinkle in his eye, he would add, 'Some of them might even be true'.

I will leave it to you to decide whether anything I have said today is true, but if you invite me back again I'll tell you what I think about it. Have a great conference.

References

Conway G., Ruttan V., Serageldin I. 1997. *The doubly green revolution: Food for all in the twenty-first century*. Cornell University Press.

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Dr Cary Fowler is perhaps best known as the 'father' of the Svalbard Global Seed Vault, which UN Secretary General Ban Ki-Moon described as an "inspirational symbol of peace and food security for the entire humanity". This facility provides ultimate security for more than 1 million unique crop varieties, the biological foundation of agriculture and the raw material for all future plant breeding and crop improvement efforts. Dr Fowler is the former Executive Director of the Global Crop Diversity Trust, an international organisation co-sponsored by the Food and Agriculture Organization of the UN (FAO) and the Consultative Group on International Agricultural Research (CGIAR). Prior to leading the Crop Trust, he was a Professor at the Norwegian University of Life Sciences, and a senior staff member of Bioversity International. Earlier, he oversaw the UN's first global assessment of the State of the World's Plant Genetic Resources. He was responsible for drafting and negotiating the first FAO Global Plan of Action on the Conservation and Sustainable Utilization of Plant Genetic Resources, formally adopted by 150 countries in 1996. Following this, Dr Fowler twice served as Special Assistant to the Secretary General of the World Food Summit and represented the CGIAR in the multi-year negotiations on the International Treaty on Plant Genetic Resources.
In 2015, Dr Fowler was appointed to the Board for International Food and Agricultural Development by President Obama. He is a former board member of the International Maize and Wheat Improvement Center, and former Chair of the Livestock Conservancy.
Dr Fowler has been recognised with several honorary doctorates and many awards including the Thomas Jefferson Award for Citizen Leadership, the Heinz Award, the Meyer Medal from the Crop Science Society of America, the Wm. Brown Award from the Missouri Botanical Garden, and the Proctor Medal from the Garden Clubs of America.