

2006 Norman E. Borlaug/World Food Prize International Symposium
The Green Revolution Redux:
Can We Replicate the Single Greatest Period of Food Production in All Human History?
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SESSION ONE: Looking Back, Looking Forward
October 19, 2006 - 8:15 a.m. – 10:00 a.m.
Ismail Serageldin

Moderator

Sir Gordon Conway

Chief Scientific Advisor, UK Department for International Development
President (retired), Rockefeller Foundation

The next speaker is somebody else who is very well known to everybody in the audience, Dr. Ismail Serageldin, somebody I've known for many years. He's had a long and distinguished career. I first knew him when he was vice president of the bank for sustainable development and chair of the CGIAR. That's where he had perhaps his biggest impact. He's a man of extraordinary abilities. He's a kind of Egyptian Renaissance man, if you don't mind me saying so. He's written books on mosque architecture, on Shakespeare. And so his current post as director of the great Library of Alexandria, one of the Wonders of the Ancient World, now transformed into this modern world of ICT, is highly appropriate. And he's going to speak about the "Ten Commandments of Agriculture."

The "Ten Commandments of Global Agriculture"

Ismail Serageldin

Director, Library of Alexandria
Former Chairman, Consultative Group on International Agricultural Research (CGIAR)

Thank you, Sir Gordon, and thank you again, Ambassador Quinn, for inviting me, the Ruan family for making this possible, and Norm Borlaug for the inspiration that you have given to not just me but practically everybody that I know in the whole world who is concerned about the condition of the human family.

My talk really is about, not just about the Green Revolution but about how in fact we could get to the Green Revolution to achieve its full promise. And to do so, I think we need to address the problems of global agriculture. And in a moment of lack of modesty I decided to call them the "Ten Commandments of Global Agriculture."

But first a brief prologue and then some revisiting of main themes. And the prologue is: Why agriculture and why global? Well, I cite one of my gurus, Dr. Swaminathan, to remind

ourselves that we are all on this earth as guests of the green plants and those who tend them – too frequently forgotten in many parts of the developing world from which I come.

But agriculture is the key to poverty reduction, environmental stewardship, and food security, as Gordon Conway has made clear earlier on. Today it is also the single biggest issue blocking a new trade agreement in the world. And that, as you well know, is where we're blocked on the Doha Round agreements.

And I'd like, as an acknowledgement to give a vote of thanks to Gurdev Khush and to Per Pinstrup Andersen for having loaned me some of the slides that I will use in some of the Commandments. They are of course innocent of the use to which I will put them, but I thank them, nevertheless.

The key themes are globalization and trade, food security and production in the role of science. On globalization and trade, we expect the demand to continue to rise in every kind of basic grain, and the bulk of it is going to be in the developing countries. But despite major production increases in the developing countries, we believe that the net cereal imports will double. In other words, the industrial countries don't have to worry about losing markets. They will have greater markets in the future as well.

Food prices we expect, if this scenario holds, will remain fairly stable or decline slightly. These are the IFPRI impact simulations over a period of time, and it's fairly stable pricing – except, if India or China tip from net exporter to net importer. They are so large, and their impact on the global available market will be high, and for example, Chinese imports are 10% of the rice needs would roughly mop up about 30% of the available world rice. And Sub-Sahara in Africa will remain a net importer for many years and would have difficulty coping with the spike in prices that would come from that. This is an example of where we see African exports, African imports; and as you can see, we expect this to continue for awhile.

Food security and production is simply a short statement. We know that production is a necessary but not sufficient condition for food security. But that doesn't mean, therefore, that it's unimportant. When people say Amartya Sen showed that the distribution was important, Amartya Sen never said that production was not important, and in fact he'd be the first to say that, with less production we have higher prices and less access. So that is extremely important.

And we need to focus on the small holder farmer. So to respond to the production challenge, we have to increase the area under cultivation or increase the yields. And for a variety of reasons, we have very limited choices except to increase the yields; and to do so, we would need to increase the biological yields, improve the nutrient content, intensify agriculture, and manage natural resources sustainably. And here the role of science comes in, from the Green Revolution to the Doubly Green Revolution or the Evergreen Revolution. What they're talking about, of course, is more diversified genetic material, less reliance on chemicals, more reliance on integrated pest management and integrated soil water and nutrient management.

Recognizing the gender dimension in many parts of Africa, this farmer produces 80% of the food, receives about 10% of the wages, and owns less than 1% of the land. We need to promote alternatives to slash and burn and also reduce post-harvest losses, and always think—

Swaminathan told me to think— pro-poor, pro-women and pro-environment. And that means that we must harness the genetic imperative and get over some hang-ups which generally have no scientific foundation. But regretfully, many of the NGOs who are now attacking the new biology have no scientific foundation for these attacks. It is, in fact, a way of combining traditional wisdom and modern science; and of course different regions will need to address different problems, but all will require the best of science – but the best of science focused on the problems of the poor. Now, that is where there is a real concern with significant absence of public goods funding research.

So whole new avenues are opening up, but they're very fast pacing the new biology. And in fact, it's a wonderful time to be working in these sciences.

Now with that prologue, let me move to the Ten Commandments for Global Agriculture, and here they are: Take them one a time, make it...

Reform policies and markets. Well, globally, we just heard, fair play is important. Today the developed world funnels nearly a billion dollars a day in subsidies to its farmers. Now, that is six times the total amount of official development assistance for all sectors, all activities, everywhere in the world. And a typical cow in the European Union receives a government subsidy of \$2.2 dollars a day, which is more than 2½ billion people receive. No wonder an African leader who was something of a wit, said at the conference I was with him at in Europe that if there's any fairness and there is reincarnation, we should come back as European cows. For no effort, we'll redouble our incomes.

It is a sad state of affairs, ladies and gentlemen. This picture that I put up there, I think, is a very powerful one. But it also is an easy step from there to this cartoon, that the notion, therefore, of let the competition begin is not quite fair under the circumstances. And I think that says a lot.

Yes, on the other side of the coin the poor farmers in developing countries have a lot to do. We have to remove the urban bias that leaves rural roads looking like that, that leaves rural schools without adequate attention or even a blackboard of those children or even chairs for them to sit on. Yes, there is a lot to be done locally. But clearly that is the first commandment – we must reform policies and markets.

The second is to focus on small holder farmers. They are the majority of all farmers in the world. They are disproportionately poor. And the returns in terms of growth, poverty reduction and improved environmental management is very substantial. So 70% of the world's poor are still rural, and the urban poor represent 30%.

But small holders represent 92% of the world's 1.2 billion that are less than a dollar a day. That's an amazing figure. And therefore concentrating on the agriculture problems of that group will have an enormous impact both on poverty reduction, food security, as well as environmental considerations.

Now, why are small farms under such trouble? Well, globalization, for example, including supermarkets even in poor countries, doesn't buy from them. Low world market prices

for agriculture, climate change would come back to that. HIV-AIDS, in Africa it is devastating, many countries. And I know that Dr. Borlaug and President Carter and the Sasakawa Foundation are doing a marvelous work in Africa. But it's an area where I think HIV-AIDS is having a major impact. And we should be aware of the potential impact of HIV in other parts of South Asia.

And continuing population growth makes small farms even smaller, and ultimately they have no political voice. Nobody cares that much about them. They are not likely to topple governments, and thus they don't get their fair shake.

So dealing with global poverty requires that we address rural poverty and a special focus on small, older farmers in developing countries, in particular to address the problem of food security.

The third point, I think is to husband natural resources, what Sir Gordon Conway referred to as sustainable agriculture and showed us from the time of the Romans people were concerned about it. Well, it's true, and I would add that agriculture is the major interface between people and nature. And sustainable development is beneficial for all, and resource degradation hits the poor worst. So agriculture tends to, in many parts of the world, have come at the expense of clearing of forests, destruction of forests.

And this, for example, from an article in *Science* in 2005, shows the impacts of global land use. There's the natural vegetation, there are the croplands, and there are the pastures and the rangelands. And in fact we see natural ecosystems being gradually displaced by frontier clearances and subsistence of small farms... intensive agriculture urban areas – by which time the natural ecosystem has become very small, and then we have protected recreational lands beginning to reappear over here.

Now, this transition in land use is in fact on a higher proportion of the landscape. We have already transformed over 40% of the total land mass of the planet, over 40% of total land mass of the planet has been transformed, 43% in that estimate in '97, probably closer to 45 by now, 46 maybe. We're using close to 60% of total water available, about 60% of all nitrogen fixed is by our fertilizer, and marine fisheries, of course, have been also impacted. So we have a big impact on the natural ecosystems.

And I would submit, therefore, that if you really want to support the environment, support agricultural intensification, support the Green Revolution, support the Doubly Green Revolution – because the most important environmental action is to reduce the need for more land under cultivation. And something that the environmental people do not remind themselves enough of, is that were it not for the Green Revolution, the first Green Revolution, we would have had to bring under cultivation another 300 million hectares of land, which is more than the total land under cultivation in Canada, U.S. and Brazil combined. An enormous transformation would have taken place were it not for the Green Revolution.

Well, intensified agriculture... habitats and biodiversity, it saves unknown amounts of biodiversity in soil that hasn't even been classified. And, of course, we therefore not only need to intensify the agriculture, we need to protect the land from soil erosion, which is affecting many

parts of the world. And today, increasingly, water is also a concern. It takes about 2,000 to 4,000 tons of water to produce a ton of rice, and much of it is used in a fairly inefficient fashion. Worse, we are pumping water in many parts of the world to subsidize energy costs that are reducing and lowering the water tables in many parts of the world. And some estimates put already 10% of world grain production, depending on the unsustainable underground water withdrawals.

Now, just to give you a flavor of what this means, this is a well in the Sahel where the water table has been dropping and they've had to dig it deeper and deeper and deeper and deeper and deeper and go all the way down there to find a few drops of muddy water. And the reason that we do this is, of course, that will lead to... and so on. It's a statistic that's not very well known. But it's a lovely statistic, it's a very powerful one. It takes one liter to produce one calorie of food on average. Now that... I spent a lot of time with Peter Glick on this, and it's between 980 liters to produce 1600 calories in a Swahilian diet and 5500 liters to produce 3200 calories in the U.S.—on average 2700 calories, 2700 liters worldwide So, a liter per calorie for production of food.

Now, what does that mean? Well, for one thing, we need more crop per drop. As David Sector used to say, we need more crop per drop. We need to think differently about yields. Yields have only so far been tons per hectare, tons per unit of land. We need to think of them as output per unit of water, not only land but water, energy, and labor content as well.

And if you look at it this way, we know that irrigated land produces more than rain-fed. In this case it's kilograms of wheat per cubic meter of water, and this is figures from ICARDA in Syria and, yes, irrigated land is about more than twice as efficient in terms of production. But supplemental irrigation is almost seven times as efficient as rain-fed and almost three times as efficient as irrigated, with just a little bit of additional water at certain times.

We need to expand our water use, recycle, reuse. Wastewater reuse is increasingly becoming a possibility. And this, for example, is vegetables produced in Kazakhstan with recycled water, courtesy of ICARDA. And there's so much more that can be done. Again, I think for Gurdev Khush's lecture here, that one of the very efficient ways in which we can reduce water use is to shorten the growth duration of plants, to improve levies for water management in uneven fields, to use laser land leveling, much better field management, soil puddling, dry sowing, and of course reduce pollution. Increasingly hard metals and other pollutants are finding their way into water that's therefore not easily usable, for example, to grow fish or other factors present.

Pesticide use has been a source of such pollution, and it shows that, with a reduction in pesticides, we can still have a significant, continuing increase of high volume of rice production with lower pesticides. And again Gurdev, who showed me this, that this comes from the Long An Province in Vietnam where stable yields are maintained while insecticide spraying was severely reduced.

We need to raise agricultural productive, not just production, because productivity would be the key to allow the small holder farmer to make some means of earning income. And to do this, therefore, their productivity must rise faster than the price declines to generate surpluses for

them. And here what I'm talking about again is measured in terms of total factor productivity – land, water, labor, energy, chemical inputs. Here is again a long-term effect of the Green Revolution with rice production and rice price being shown here. And therefore future challenges mean less water, less land, less labor, less chemicals to produce more food for an increasing population that will at least have two billion more people on the planet.

Transgenic crops and biotechnology must be harnessed. The new technologies must be harnessed. And as was pointed out, increasingly developing countries present a larger percentage of the total amount under cultivation.

If you look at, for example, rice research – and again I'm grateful to Gurdev for this – there are three general strategies. If there is a biological ceiling, if there is a current observed ceiling, one of them is to raise the yield ceiling. The other strategy is to reduce or close the yield gap. And the third one is really sustain the current yield – but that's not enough to meet with our current needs, so we have to try to look at each of these separately.

And to raise the yield ceiling, we have to invent a new plant type right now – a new Green Revolution, a Doubly Green Revolution, maybe going towards this super rice, as it was called once. Here is the new plant type rice. This is his nomenclature. He is much more modest. I would have said “Super Rice! Yay!” He says, “New plant type rice.” But here are some of the yields which show we are already at 15.2 tons per hectare. Experimental rice hybrids – that increase is bigger – about 11%. And possibilities of exploring shifting from C3 plants to C4 plants – as you know, the Calvin cycle, which showed that the carbon atoms in the molecules have a certain amount of ability to photosynthesize with other plants, such as sorghum, sugar cane, maize, four carbon atoms of C4 plant. And if we could do that transgenically, it would be a huge jump in our effectiveness in the photosynthesis of plants.

Closing the yield gap requires analyzing ‘why is it there?’ Well, people lose a lot to weeds, disease, insects; and therefore if we find ways of reducing these losses, then clearly we would come closer to the optimum production levels. And that means fighting bacteria blights, finding the genes for it. This was the famous Xa21 and plus the transmitting of genes that took place. And as you can see here, the reactions of bacterial blight from inbred genes is enormous against a control, and of course the stem borer damage has been also controlled with transgenics. Here is the larva from the transgenic rice at the top and the controlled at the bottom. And also of course better use of IPM and better management generally, biologically controlled generally.

Again, I must emphasize that we need to think in terms of total factor productivity – land, water, labor, energy, and animal inputs as well. And therefore we need the whole range of technologies to address that issue, and that is what the Doubly Green Revolution will be all about.

But then the fifth one is really to improve nutritional content, because at the end of the day the amount of food produced is to feed a certain amount of population, and if the population gets more of its food from less agricultural output, that is definitely better. And biofortification is really just the beginning of enormous health benefits. The most famous of these cases, of course, is the one about golden rice, when you have bacterium and two genes from daffodils were taken and plasmas of those three genes were implanted to create the biochemical pathway to bring the

pro beta-carotene from the leaves of the rice plant into the kernels and to increase therefore vitamin A and reduce vitamin deficiency among children, which accounts for over half a million deaths and 14 million cases of premature blindness.

But the case here, you can see it's called "golden rice" because of that color, but it's not the only case. We also have sweet potatoes with and without beta-carotene and now high-iron rice, and other means are being looked at.

This is one of my very favorite slides, and it really justifies, of course, our winners for the quality protein maize. These two pigs are twins. One was fed regular maize, one was fed quality protein maize. That says it all better than the graphs of lysine content and the like. And I'm very grateful that the World Food Prize also focused attention on fish as a potential source of protein for people and take it into a more serious way of farming in the future to produce longer, more productive lives for people.

And the sixth is really to address short-term vulnerability, because most of the farmers we're talking about live very precariously. And the downside is hunger and famine and death, and climate change is increasing their vulnerability. Right now we have floods and droughts are cyclical, yes, but they're becoming more severe.

And this picture shows that in one year, in this case in the mid-eighties, a slight movement of the Sahara changes either bringing under or removing from cultivation an area that is over 20 times the size of the Netherlands. So the slight fluctuations are not slight fluctuations, they are enormous fluctuations in what they bring. Farmers are also susceptible to uncertainties such as locusts. But the most important thing is that pictures of what we call low-potential environments such as these put the farmers at great risk. This is the standard, looking at the graph of the variability of rain in Kenya. But what is of concern is – if you look over a 50-, 60-year period, you will notice that, yes, the fluctuations are there, but the graph tends to be going downwards. The area is on fire, and drought is very much likely to increase. And these are some of the climate change models that we have that show that we've had fewer days of planting in some areas, but the variability is very, very significant; because what it does is climate change increases the water, but redirects it in certain parts.

The seventh commandment is really not to forget the gender dimension and to empower women. And this is central because they are now bearing the cost of enormous uncertainty in the world, and that means they should get a better break on education, healthcare, income, credit—Muhammad Yunus, of course—employment, access, and decision-making. And they also do a lot in terms of solidarity and support. So educate the girls and empower women – they are the key to so many things.

The eighth point is to reach out to the ultra-poor. Market incentives do not work to the people who are in the ultra-poor, it was shown by Gupta. People who live in conditions like those in the pictures here in front of you are not significantly affected by incentives for markets. And increasingly, internally displaced people are a serious problem in many countries.

The ninth is to support science. And we need more support for science in developing countries, not just technology transfer, but in the countries themselves we need more scientists. If

in income the rich are 40 times as rich per capita as the poor, they actually spend 220 times as much per capita on research, and that creates a divide in science and technology capacity. And increasingly, you will note that as you look at a percent of GDP, being by all countries here, the blue is the public part. The red is the private sector part. The private sector part plays a very insignificant part in developing countries, and thus we must find a way of creating new forms of partnerships.

And I had the privilege of working on an inter-academy commission to build capacity in the countries that presented to the U.N. in 2004. And we recognize that they require policy, human resources, institutions, public/private partnerships, and financing mechanisms need to be put in place. And today I have the privilege of seeing that Calestous Juma will be here tomorrow. He and I have the privilege of co-chairing the African Biotechnology Panel, which we hope will make a very, very powerful statement on the need of that for Africa itself.

Last commandment, the tenth commandment: Translate rhetoric into action. We've had many past declarations, many government announcements. Remember President John Kennedy, World Food Congress in 1963 – "We have the capacity to eliminate hunger from the face of the earth in our lifetime. We need only the will." Well, regretfully, declarations, plans, targets, are not action. And here it's shown in that cartoon – we're still lacking one key translator... English/Arabic, Arabic into French, English/Swahili... But rhetoric into action is still missing.

So these are the ten commandments that I think will enable us to do so much. And working all together there is so much we can do for a whole generation and for the whole world. Thank you.

Sir Gordon Conway

Thank you, Ismail. That was a real tour de force. And I don't know what all you felt, but it seemed to me that those ten commandments really rang true.