Preparing for Future Challenges of Water Issues

Q&A[1]

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Jennie Popp: For two days we have talked about agricultural biotechnology and water. What are the take-home messages from your presentations? In short, what is the prospect for agbiotechnology to address water issues in the future?

David Zilberman: I didn't address water specifically, but a key point is that, through agbiotech, we are able to produce more per unit of input. Any technology that increases yield, for example by pest control, is affecting water positively. A lot of people say we need drought-tolerant varieties. That is true. Improved drought tolerance is important, but by improving pest control we save water. If the overall performance of the system is improved, then water will be saved. If we have less waste, water will be saved. When we look at something like water we have to look at the direct effect, which is a technical challenge that, I think, agbiotech will be able to solve in time. However, agbiotech has already drastically improved the efficiency of inputs, including water.

[1]Some of the audiorecording, from which this written record was prepared, was of poor quality, rendering it impossible to accurately represent dialogue. Every effort has been made to provide a faithful transcription.

Reagan Waskom: David gave a great answer from a macro perspective, so let me share my thoughts on the micro perspective. One of the points I tried to make during my talk is that drought tolerance and water productivity are two different things. They get confused a lot, and I think they get confused in the biotech discussion in particular. When you are breeding for drought tolerance you are breeding for that ability of the plant to "hunker down" under drought conditions to reproduce later, or wait or to get through it, so to speak. Drought tolerance is different from breeding for more productivity per unit of water. And so David's point of view of more productivity out of that unit of water is really important from the macro scale and the question is can you confer those traits on plants genetically in an inheritable way. That's a more difficult and interesting question because these don't tend to be single-gene traits. These are multi-gene, complex traits that get you to water-use efficiency—if you want to use that term—or even drought tolerance. I like this question because I think that there is a lot of over-promising in the biotech sector. I run into people all the time in water circles and in ag circles who think that biotech is going to solve water problems in agriculture. I'm sorry, but I have yet to see that and I think we should under-promise and over-deliver rather than the opposite. I won't say that we shouldn't continue to pursue both drought tolerance and water productivity, but I think we need to be realistic about the way plants work and what it is going to take to get us there and to increase food productivity. I had the privilege of sitting on Monsanto's water-advisory committee for a couple of years and watching them in their development of the so-called drought genes, and Colorado State University has gotten to test those lines. We've got plots going. I can't show you the data, but the results of the first gene are very incremental. Can they get to a second gene? Can they get to multi-genic? Can they package this in a way that really gets a more water-efficient plant? I don't know, but I think we can get to overall greater productivity and I think that is maybe a better breeding target.

Zilberman: I agree. We need to under-promise and over-produce, but I think we also have to recognize what we have done. And we have already increased the productivity of water. I am responsible for assessing drought tolerance for the Gates Foundation and the thing that drives me crazy about Gates is that they want to have drought tolerance where the impact would be minimal. With *Bt* corn in Africa they can solve the water problem and other problems immediately. The key issue is not solving drought tolerance. What you really need to do is to increase productivity of available natural resources. If you have less pest damage, automatically water-use efficiency increases. Achieving drought tolerance is challenging. We have to first pick the low-hanging fruit and show to people what we have done. We haven't shown people that we have actually achieved a lot with GMOs. We don't need to wait until we have better ways to save water. What we have to do is to improve productivity of agriculture and then see what are the benefits.

Waskom: We are trying to figure out how to cut water use in crops and to grow stressed crops. What happens when you put crops under stress? Spider mites and aphids and stalk rot, right? Bad things happen. Plants do respond, but, if you put a plant under stress, things attack it. This is another aspect of this water-use efficiency question.

Jed Colqhhoun: The other two speakers have summarized it well, but just a couple of closing points on that question. First, the slide showing the Colorado River and the demand for water versus the supply over time is revealing. If you look at the gap between supply and demand, the magnitude of the problem there—and in other places—is too great for one solution. I agree that some of us see biotechnology as the silver bullet that will solve all of our problems. I also agree that the pieces that biotechnology brings to the table to improve production can be a component of that solution, but the magnitude of the problem is just too great at this point to rely on that. Gains are to be made in improving the recovery of what we produce in agriculture after it is produced, whether it be the efficiency of feed for example, whether it be recovery of corn products. Think about the recovery rate on corn, the grain versus the rest of the actual plant. It's still pretty low. We leave a lot in the field at this point if it's not silage. Also, perishability is a factor—allowing more of what we produce to be used may be a backward way to attack this problem, but it may get us a lot farther than tackling individual components using biotechnology.

Rick Bennett (University of Arkansas, Fayetteville): Dr. Zilberman, you showed some data that indicate that GM crops would have a greater impact on productivity in Africa and developing countries than in the developed countries, and I think that part of your explanation is that using GM crops free them up to use more pesticides. However, GM crops are not planted very much in Africa. Africa has been pretty much excluded from agbiotech because they can't afford to plant GM crops. Have you or anybody else done an economic analysis of the benefits of GM crops in Africa versus the cost of food aid? Because somebody is going to feed Africa. If Africa can't feed itself, North America—Canada, the United States—and Europe will have to step in and feed Africa. Do you know what the analysis is of food aid versus planting GM crops?

Zilberman: The issue is not affording it. There are two main constraints. First is the regulatory system. In Africa there are complex regulatory systems that make it difficult to introduce new GM. This regulatory system is excessive and unjustified. Secondly, the political decision has been made in many African countries not to allow GM because they are connected to Europe. They are influenced by Europe. Europe has much more to say in Africa than we have to say. We have an organization in the United States, PIPRA, Public Intellectual Property Rights for Agriculture, which collects all intellectual property of universities on GMOs and you can move it to an African university and you can introduce it there. So the big issue in Africa is not cost. The big issue in Africa is regulation. Either safety regulation that can be done if someone would invest in it, but I think in many cases is redundant. More importantly, African nations want to go with Europe and ban it. There are many examples of the effective adoption of GM in Africa. Burkina Faso, one of the least developed countries in the world, adopted *Bt* cotton and increased farm profitability by 60% by increasing yields by 70%. South Africa has one of the most advanced adoption of GM. It has increased yield drastically and it is profitable. Tomorrow, if Gates decides to invest in *Bt* corn in Africa, he can invest in Ghana and other countries and it would be profitable. It will increase yield and it will do a lot of good things. Now my calculation is that if, tomorrow, you have adoption of *Bt* corn and soybean in Africa and Europe, it will have the same effect, more or less, as adoption of biofuel. Now, in Africa the problem is not only pests. In Africa the problem is that you need to use fertilizer, *etc*. But the yield effect of adopting GM in Africa would be so drastic that it would reduce price significantly. So, to me, the key issues are political. It is a public debate and a political debate rather than a technical debate. So, what happens is that people like Gates say, "Gosh, the African nations don't want GM. They are afraid of it because they are afraid of the Europeans. So we will bring them drought-tolerant varieties." I agree that drought-tolerant varieties would solve the problem. There are lots of other things that GM can solve. It was mentioned that you can improve the digestibility of soybean. That is something that we know is available, but no one has investigated it because people are afraid of it because of the political environment. To me, the key issue today is the image that GM is not sustainable, not good for the environment, *etc*., whereas we have evidence now that already GM helps the poor by reducing prices and the global environment by saving land and it saves water and in Africa it can save aid, reduce prices and increase water-use efficiency. The issue is political.

Ralph Hardy (National Agricultural Biotechnology Council, Ithaca) Dr. Zilberman, in May of 2012 an organization called PG Economics Limited, based in the UK, published a 187-page survey called *GM Crops, Global Socioeconomics and Environmental Impacts*, covering the period 1996 to 2010. It's a heavily referenced document. It made statements like, "Since 1996 the cumulative increase to farm income from GM technology has been $78 billion." It divided this up into a number of countries. It provided the data for India and China where, in recent years, the major economic impact has been from *Bt* cotton. Should I have comfort with this document as a valid source of information or shouldn't I?

Zilberman: The document is not bad. The National Research Council produced a report about GM that included economic and environmental effects, and I feel better about that. The UK report doesn't take into account the impact of GM on food prices. GM actually increases the affordability of food, so, to some extent, they underestimate that aspect and overestimate the impact on the well-being of farmers. All in all, it's a decent report, but the US NRC report is better.

Steve Slack (Ohio State University, Wooster): Jed, this question is for you. The Central Sands is a very proscribed area. It's a very intensive well developed agricultural system. And you've laid out a lot of the variables. Could you describe how the agricultural industry is responding to some of these tensions and pressures and also whether or not NISA is playing any kind of a role in that, other than observational at this point?

Colquhoun: There are two pieces to that. Grower involvement has been very strong. Over the last couple of years, we have created what we call the Central Wisconsin Ground Water Task Force. In the past year, the Task Force has integrated municipalities, industrial water users and, most importantly, the lakes associations and river alliances in that area to work together towards finding some common ground. We have involvement also, as I mentioned, from folks like Trout Unlimited and Ducks Unlimited. This is a community-based problem. The Wisconsin Institute for Sustainable Agriculture's effort is to help provide on-the-ground solutions, but not tell people what their communities should look like. We have worked very hard to maintain that with this particular issue. It is an opportunity for play-space learning and experiential learning for our students, but we are looking for the community to work together to find common ground. Some very creative pieces have been put forward that would at least be interim solutions that involve the growers assisting the lakes associations. For example, the growers have, out of their own pockets, recently invested heavily in well-monitoring technology—monitoring the water levels in these high-capacity wells every 15 minutes around the lakes of concern and such. Very interesting information has already come out of that; the water levels in the wells around the lakes are actually higher than the lake level—much higher—by 15 feet or so in some areas. So, something else is going on in this picture and that's where community involvement comes in. Little Plover River—growers have been filling the headwater of that river for over two years, just to keep the water running as an interim solution to keep trout in the river. They pump out of their irrigation wells into the headwaters of the river. Is it a long-term solution? Of course not, they realize that. But they are at the table with the community, to assist in moving forward. In terms of NISA itself, again it comes down to pieces like measuring water levels in wells. How do we do that in a reasonable way? How do we determine evapotranspiration in a changing-crop scenario and crop rotations where we are growing shorter-season crops with more shoulder seasons—spring and fall—with no crop on the land? How do we assess the impacts of that related to parameters like water? This is where NISA steps in with reasonable assessment programs to try to document baselines, show improvement over time through some of this work and report back against that to everyone from the consumers and the lakes associations and also to the value chain and the purchasers of those products.

Rick Bennett (University of Arkansas, Fayetteville): Reagan, you mentioned that stream flows across the Ogallala Aquifer are not replenished by the aquifer. Is that correct? And you went on to say that, as the aquifer declines, the stream flows decline. I'm asking the question because, obviously, farmers are pulling water off the rivers that cross the aquifer. I'm not quite sure I'm understanding what is happening there.

Waskom: It's an interesting scenario because those streams pick up rainfall. They are not snow-melt driven, they are precipitation-driven streams. But, as they came across the aquifer, historically they were known as gaining streams. It's complicated because there is usually the Alluvial Aquifer and then there is the regional High Plains Aquifer with a connection between them. But as we draw down the High Plains Aquifer, the Alluvial

Aquifer starts to feed it, which draws the stream down. It's a cascading effect. So, yes, those streams were gaining from the Ogallala Aquifer, or the High Plains Aquifer indirectly. Kansas recently sued Nebraska and Colorado got implicated in that on the Republican River as well. So now we are in the painful process of the pullback and this is why the title of my presentation was about optimizing water for food, environment and cities. I didn't use the word sustainability because we're not even close to sustainability. We have over-allocated almost all of the surface and groundwater systems in the west. We have a long way to go. Right now we're in an optimization mode with respect to putting 9 billion people on this planet. We are going to have to reset the bar for what is sustainability. We will come back around to this later when we have withdrawn these aquifers and we have taken that agriculture out of production and we are still feeding those people. We are in a chaotic realm right now where we realize the connection. It took us a long time to get into this problem—50 years of slow, incremental, over-allocation of these systems. Our models show us what's happening out there, and it's going to be turbulent. It's going to be really tough on producers. Federal support can soften the landing only to a certain extent; some producers are already crash-landing.

Zilberman: What do you think about the use of urban wastewater to increase supply?

Waskom: That's a great question. The prospects for reuse are important for us to investigate in agriculture and many repercussions ripple out from them. In places like Colorado's Front Range, urban growth is occurring on previously irrigated land. We are substituting blue grass and houses for corn and it's amazing. An acre of 4 or 5 houses and bluegrass is about equal to an acre of corn. It's a complete substitution, but what is starting to happen now, of course, is we are having to reach further and further into agriculture to get water to sustain growth. So sustainability is about sustaining growth, but not food in that particular case. The prospect for agriculture to provide this service—we haven't heard the term ecosystem services—of assimilating society's waste and profiting from societies waste is a rich area for consideration. We are looking at it in Colorado. In Florida and California a lot of work has been done in water reuse because of their discharge standards. Their discharge standards got so difficult that they began to reuse in the Central Valley and in Florida because it was cheaper to do that than to put that wastewater flow back into the stream. A lot of the other western states haven't gotten there. Urban conservation, ag conservation, reuse, markets—we haven't talked about water markets—there is huge potential in terms of efficiency, in terms of allowing some fungibility about the way water moves across systems and across states and basins, which can help producers become profitable. That may be spoken with more of a western point of view than an eastern, but I think all of these are things that academia can bring a lot to. And crop breeding is part of it because that reuse water is higher in salinity. It's higher in sodium. It's got a lot of stuff in it. We've got to figure out how to utilize that, break it down, assimilate it, *etc*.

Zilberman: The issue of water marketing—all of California is based on moving water from A to B and it increases productivity immensely. For the last 30 or 40 years, we haven't allowed water trading so one reason that people don't adopt more advanced irrigation is that if you save water you lose water rights. That is very important. Even in Florida you have a situation where people don't adopt even a low pressure center pivot because of the fact that they cannot trade water. In California they moved 10% of the water from agriculture to environment and increased productivity of water quite significantly because of water trading. So, this is another solution that I think is really important.

Waskom: Yes and I might mention Oregon passed a saved- or conserved-water statute where institutions and organizations can upgrade their systems and conserve water. They have to put half of that water back into environmental flows and the other half of that water is available for fungibility, for markets and trading. And that has stimulated some really neat solutions around salmon in Oregon by a simple change of the law, and things cascaded from there. It doesn't fix everything, but, again, it's an example of how institutions and markets can drive change.