Workshop Summary[1]

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Four parallel workshops were convened at the end of the second afternoon. Each group addressed the same questions. Reports on the discussions elicited by the questions were delivered orally at the end of the conference by those listed above.

At this conference, we are discussing both technical and cultural approaches to dealing with challenges of water sustainability. Beyond the specific topics being covered in this meeting,
—What technical approaches should be pursued to improve efficiency of water use in agriculture?
—What policy changes or educational efforts that should be pursued to help improve cultural practices?

New technologies:

- Small scale on-farm approaches: drip irrigation; re-use of wastewater for irrigation; run-off capture to control loss of nutrients and soil.
- Identify knowledge gaps for using these new technologies and scientifically document how effective they are, including economic analyses.

[1]The discussions were facilitated by Chris Henry, Anna McClung, Tom Riley Jr. and John Rupe, and notes were taken by Kim Keeney, Cindy Morley, Lacey Nelson and Samantha Roberson.

- Novel technologies need to be approved by NRCS[2] to be eligible for crop insurance and bank-financing of farm operations.
- Identify C4 plants that are better suited for drought-stressed production areas. Consider the potential for conversion of C3 crops to C4 pathways.
- A nationwide systems analysis is needed across agriculture to assess where the most water-efficient crops are being grown in each region. If that analysis concludes that certain crops are performing inefficiently, what infrastructure needs to be developed, and what social shifts need to occur for improvement?
- Additional assessments of water storage are needed, with possible adoption locally of more efficient approaches.
- Replacement of flooded rice with upland rice should be considered.
- Irrigation should be triggered on the basis of soil-moisture content or evapotranspiration measurement.

Policy/educational changes:

- The Farm Bill should include language that is supportive of innovative water-saving methods and use of water-efficient crops by growers in areas of moisture deficiency.
- Better assessments of land use and regional planning are needed. Irrigation of crops or dairy operations in water-scarce areas (like New Mexico and Arizona) may not be good use of public natural resources. There is need for broader understanding that water is not "free"; societal and environmental impacts result from inefficient use of water.
- Incentives are needed to encourage adoption of new technologies. NRCS is limited on resource availability per project; many more requests are received for support than they can fulfill.
- Education of policymakers and regulators is needed. Large companies are setting priorities, not necessarily for the public good. Fundamental to this is conducting solid science to provide the basis for guiding policy.
- Other countries are more progressive in desalinization programs. We should learn from them, to utilize ocean-water resources for agricultural production.
- Educational opportunities should be provided to farmers to assist them in utilizing remote-sensing technology.
- An analysis is needed encompassing all users of water nationally with the focus on withdrawal reporting.
- In areas where agriculture is not already diversified, diversification should be encouraged in order to secure local needs.

[2]National Resources Conservation Service.

- Charging for water usage should be examined, including investigation of how producers would be affected.

The US Department of State recently launched the US Water Partnership to deal with water challenges that can potentially increase regional tensions and political instability worldwide. How can agricultural researchers best direct their efforts to deal specifically with such social and political aspects of water use?

- Coordination of research projects across regions could have broad/national impact. For example, research along the Mississippi River should be consolidated, from on-farm point-source pollution and water use to hypoxia in the Gulf.
- Grass-roots interactions will build communities that care about these issues and come together to help solve problems from multi-faceted perspectives.
- The impact of other industries on water use and pollution needs to be documented to achieve better understanding at the watershed level. Agriculture may be receiving greater blame for pollution than is warranted.
- The public needs to better understand the value of products of agriculture (food, fiber, fuel) in relation to its use of natural resources. Public perception of farmers should be as good stewards of natural resources who feed the world.
- The United States should be a leader in good stewardship practices and communicate accordingly with other countries.
- Research on water sustainability should be focused at the producer level. Benefits must accrue to farmers first in order to not only sustain farming, but to ensure adoption of new conservation practices.
- Development of agriculture-related infrastructure should be emphasized within other countries, including germplasm collections, gene banks and marker-selection capability.
- Altruism should be part of student training to encourage the desire to make things better.
- Scientists should take care to show respect for the public at large and the cultural forces that shape public opinion, to avoid giving the impression that they know all there is to know and have all the answers.

In a recent study, Hoekstra and Mekonnen (2012)[3] estimate that agriculture contributes 92% to the global freshwater footprint of human activity.
—Should we be concerned that there is such a high proportion for agricultural use, or are such high amounts inevitable?
—Given this high amount, should there be more focus on educating consumers about the needs of agriculture for food production?

[3]http://www.pnas.org/content/109/9/3232.

Inevitability of high water use:

- The discussion should be reframed to clarify the difference between agricultural water use and water consumption.
- It is essential to be able to estimate accurately agriculture's water footprint. There was consensus that 92% is an over-estimate; recycling of irrigation water was probably not considered.
- Deriving lifecycle models of water use are fraught with difficulties because, inevitably, they become so complex as to be meaningless.

Consumer education:

- There is need to communicate that farmers are not irresponsible about resource use.
- Education is needed at the K–12 level to engender better public understanding of food production, environmental stewardship, and water use for crop and animal production.
- Marketing by industry is more effective at leading the public than is our education system. There is pressing need to reverse the trend of the public being further and further removed from food production and ever more suspicious of science.
- Few consumers understand that many sources of our food are of high water content, requiring significant uptake of water.
- There is need for education, not only in places where water is scarce but nationwide. It can be especially important in areas where water is plentiful. For example, a person in New England may routinely keep a tap running until the water becomes cold for drinking, whereas in the west that's less likely.
- One of the problems with improving awareness of water sustainability is that consumers don't have a metric for comparing products. They have metrics for how many calories are in a product and whether it's organic. Certification or package labeling that an item was produced in a sustainable way would be helpful in promoting awareness and to help consumers make wise choices.

What other topics are worthy of discussion?

- We need to more effectively communicate the overall potential impact of agriculture, not only for food and feed production but also on resource use—including water—climate change and human nutrition and health, and use this to justify increased funding because agricultural research has huge potential for addressing 21st-century problems.
- Better understanding is needed of the long-term implications of government policies, such as the Farm Bill, and efforts to improve conservation.
- Better understanding is needed of competition for water resources for agricultural and urban uses. We need to stop blaming farmers and change people's perception

of how this can be a win-win proposition in terms of environmental and ecological economics as well as food and feed production.

- One of the biggest problems is funding; where do we look for it and how do we convince those who have the funds to increase commitments to agricultural research?
- "We are regulating ourselves into the ground."
- More farmer feedback would be helpful.
- Groundwater depletion is an increasingly important issue in Arkansas and elsewhere; it deserved fuller discussion at this conference.
- Grower reluctance to change practices is a significant issue. As an example, in west Texas, at some point growers will be unable to produce cotton due to water depletion, but there is little impetus to adopt conservation practices. Legislation to regulate water use was struck down by the Texas Supreme Court.
- The role of wildlife habitats in water use deserves attention. In Arkansas, for example, some farmers generate as much income from renting flooded fields to duck hunters in the winter as they do from crop production. The farmers may make potentially detrimental adjustments in how they grow their crops to accommodate hunters.
- Given that water is a scale-dependent issue, a focus for a future conference would be to examine areas where water use is intensive, *e.g.* for rice production, for opportunities for crop diversification to decrease water consumption. This would probably be achieved via regional life-cycle analyses.
- Another subject for a future conference is the issue of transferring farms across generations. Young people who wish to enter farming are faced with significant challenges. It is virtually impossible get into agriculture because of land prices, thus threatening future production.
- Another possible conference focus would be to explore what people eat and why. Understanding consumer preferences may help inform farmers to increase their profitability. This could include consideration of the role of technology and the extent to which consumers care about genetically engineered foods.

Ken Korth: Any comments from the audience?

Thomas Redick (Global Environmental Ethics Council, Clayton): One of the problems I see is lack of agreement on how much water is used by agriculture. We were given a number by Hoekstra and Mekonnen: 92%. CAST, the Council for Agricultural Science and Technology, produced a report in 2009[4] that 59% is used by agriculture. However, neither of these sources provides a clear idea of how much credit may be allotted to aquifer recharging or how that will be worked out.

[4]http://www.cast-science.org/publications/?water_people_and_the_future_water_availability_for_agriculture_in_the_united_states&show=product&productID=2950.

Reagan Waskom (Colorado State University, Fort Collins): It was mentioned that we need better numbers. USGS[5] is doing a national water census right now. It's a 10-year effort. But the problem referred to results partly from the way that we report these numbers. USGS does withdrawals. Other people do consumptive use. Other people now are doing footprinting. We mix and match these and ag doesn't like the way the numbers look. But I want to challenge this, particularly around water footprinting. Tony Allan at King's College, London, came up with the idea of virtual water—how water is embedded in products and processes. He did it not to lay a value on that, but to show how water is moved through various products and around global trade systems, so you can begin to look at substitutions, *etc*. This idea then gets overlain with water footprinting. When you determine a carbon footprint you are looking at a resource that has impacts on climate far beyond its time. If you are looking at water, it is very different. Who cares if it takes half a million gallons to grow 150 bushels of corn in eastern Iowa? If a value is laid on top of that, a consumer may think that's a bad thing: 500,000 gallons to grow 150 bushels. Part of the problem is the way that a value gets overlain on that. Does it matter that half a million gallons are withdrawn from the Ogallala Aquifer to grow that 150? Maybe that's a different discussion. Part of the educational opportunity that we have is to deal with this issue of water footprinting and get away from the idea that it's bad that it takes a lot of water to grow our food. That's the reality of growing beef or corn or whatever. Can we make substitutions? Yes, and that was Tony Allan's point with virtual water. Maybe it doesn't make sense to produce milk in Saudi Arabia—using desalinated water to grow alfalfa to support a dairy industry in the desert. Maybe you just move milk solids from Europe.

David Zilberman (University of California, Berkeley): One system of accounting is the market system and the good thing about the market system is that most of us are paid in dollars. We are not paid by footprints. So, to some extent, even if people hate it, they take it seriously. Now the challenge is to introduce environmental values into a market system. For example, if you have a lot of water in some parts of Canada and you use it for irrigation without environmental implications, then there is no problem. If you draw water from an aquifer it may affect your ability to produce in the future, and that will be something that will enter the economic system. I like virtual water because it is, basically—excuse the expression—economics for dummies. It brings some rational cost of tradeoff into the decision-making. The reality is that we live in a system where we have tradeoffs and we pay for things. The big problem is that a lot of environmental amenities are not translated into things that people are paid for. As long as people don't pay for things we can speak about them as much as we want, but nothing will change. The only thing that may happen is that we will make political decisions that, sometimes, will actually make things worse rather than better. Depleting groundwater, in many cases, is a big problem. Linking all of what we do to some sort of a market economy is important.

[5]United States Geological Survey.

Another thing that is important is to recognize to what extent it may be worthwhile to move water from A to B recognizing that moving water is problematic. It's costly, but there is a lot of benefit.

Becky Cross (USDA National Agricultural Statistics Service, Little Rock): A farmer-based survey is available, the Farm and Ranch Irrigation Survey.[6] I invite everyone to see what data are available and to provide feedback so that the information may be provided in a different, or better, way. That is what we are here for—to tell the story of farming in America.

[6]http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Farm_and_Ranch_Irrigation_Survey/index.php.