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Innovations to improve water productivity – Reflections

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Ensuring that all people have access at all times to enough safe and nutritious food to lead a healthy and active life is undoubtedly one of the most urgent challenges of the 21st century. Food requirements will likely double by mid-century as a result of both population growth and improving diets in many parts of the world. At the same time, the use of water for both human and environmental purposes will need to increase, leading to mounting degradation of water quantity and quality. All this means that water available for agriculture in the years to come will be much more limited than at present – a situation that is likely to be inherently more complex as a result of climate variability and change.

To ensure sustainable global food security in the face of growing demands for scarce water resources to meet other human and environmental needs and climate change, action will be needed on several fronts. Reducing food waste across the food supply chain would reduce pressure on our natural systems including water in particular (Gustafsson and Lundqvist, 2012). Increasing trade in agricultural products would enable water-rich regions and countries to supply more of the food required in water-short areas. And innovations to boost water productivity through improvements in the management and use of water by and for agricultural and food systems would enable us to produce more food with less water – and less energy too.

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1. Examples of innovations to improve water productivity

Innovations to improve water productivity were recurrent themes at the 2012 World Water Week, especially at the workshops on "Rainfed Production under Growing Rain Variability: Closing the Yield Gap" and "Best Use of Blue Water Resources for Food Security". At the rainfed production workshop, for example, the International Water Management Institute presented new approaches to rainwater management in Ethiopia which involved the integration of technologies, institutions and policies (Sharma, 2012). Likewise, the workshop on irrigated production included presentations on innovative ways to combine irrigation methods, management models, new technologies, and irrigation networks to maximize water efficiency (Hammar, Marangoni and Nikhade, 2012). Innovations for water productivity were also highlighted at other World Water Week workshops and side events; my colleague Suat Irmak, for example, outlined his work with the Nebraska Agricultural Water Management Network which, by coupling high efficiency irrigation systems with soil moisture sensors and farmer outreach, has saved over USD $35 million in energy costs through increases in water use efficiency (Irmak, 2012).

As these presentations highlighted, to improve water productivity we need combinations of technological, social, institutional and policy innovation. On the technology front, perhaps the greatest gains will come from the merging of modern information and communication technology with irrigation and water management technology to create more output from less input. In western India, for example, farmers are using mobile phones to activate electric irrigation pumps in their fields (Srivastava, 2012), and pastoralists in Kenya are uploading on-the-ground water conditions to enrich satellite data, forming a real-time map of forage and water conditions (Kamadi, 2012). On the institutional innovation front, the Natural Resources Districts in Nebraska provide an excellent example of how local level management and control of groundwater can improve both productivity and sustainability (Bleed, 2013).

Importantly, these combinations of technological, social, institutional and policy innovations need to be developed outside as well as inside of what has been traditionally considered the "water domain". Drought tolerant crops, for example, can have a huge impact on water productivity in water-scarce contexts. And innovations need to be developed at a range of scales. Not coincidentally, the examples noted earlier cover farm, community, watershed and state scales. Significantly, water productivity gains at farm scales do not automatically ensure equivalent gains at the watershed and basin scales, since these are highly context-specific and depend on the nature and extent of water re-use.

Likewise, the development of innovations in water productivity does not automatically ensure adoption, which is often constrained by lack of appropriate supply chains, technical assistance, markets, and incentives. In the Nebraska network example noted earlier, farmers have a strong incentive to reduce water usage because of high energy costs. But where energy or water prices are low, the incentive to farmers to improve efficiency is also low.

Despite these and other excellent examples, we urgently need to fast-track water productivity innovation and adoption, both of which are still low in relation to such sectors as energy and communications and especially in relation to the scale of the challenge. Indeed, it is fair to say that we will not be able to achieve future food security with less water without a marked increase in innovation in water productivity.

2. Systems of Innovation

Institutionally, the development and adoption of innovations in water productivity will require 'systems of innovation' involving a range of actors, from public and private Universities and research institutions to producers, water management agencies, and the private sector. The range of private sector groups that develop and/or use innovative water technologies and processes is broad : seed companies in the business of developing drought-tolerant crops, irrigation companies that develop and manufacture high efficiency drip or pivot irrigation systems, companies developing information technologies that can be coupled with precision irrigation technology to further

improve water productivity, and food and beverage companies endeavoring to use water more efficiently in all aspects of the food production process.

Academic institutions will need to play a strong role in this quest for innovation. To contribute effectively to this quest, however, they will need to be creative in their approach. For example, they will need to find novel ways to bring together expertise in a range of disciplines, while at the same time emphasizing the need to connect research with practice. Research will need to have a strong focus on achieving more food security with less water at multiple scales and in multiple contexts, in both irrigated and rainfed agricultural areas; emphasis should be on field-based 'research in action', drawing on existing experience with advanced agricultural water management practices. University researchers will need to be collaborative, engaging in strategic partnerships with other groups with complementary strengths. Perhaps most importantly, Universities will need to educate the next generation of innovators in water productivity through appropriately structured educational programs.

3. The Robert B. Daugherty Water for Food Institute at the University of Nebraska

The recent establishment of the Robert B. Daugherty Water for Food Institute at the University of Nebraska provides an example of the kind of 'frontier' academic institution that is needed to foster innovations in water productivity. Our mission is to have a lasting and significant impact on achieving more food security with less water, by conducting scientific and policy research, using the results of research to inform and advise policy makers, and educating the necessary human talent. We work both locally at the center of one of the world's most important irrigation and food producing areas and in other parts of the world facing critical water for food challenges, fostering research at various scales and in a range of contexts. In doing so, we are building on our location in a highly productive irrigated and rainfed agricultural area with decidedly innovative agricultural water management practices, and our being part of a leading land-grant university with considerable expertise in an array of highly relevant disciplines and a tradition of connecting research with practice. Initially, we are concentrating on Nebraska and India, China and Brazil, with selected activities in a limited set of countries in Sub-Saharan Africa and West Asia and North Africa.

Importantly, the institute has been established as a creative 'distributed institute,' drawing on affiliated faculty from departments and colleges across the University through creative internal arrangements aimed at building bridges across disciplines, across the water and agriculture/livestock communities, across the public and private sectors, and across the worlds of small- and large-holder agriculture. Beyond the University walls, we are expanding our reach through strategic partnerships with other universities and research groups, public and private institutions, and NGOs. Next year, we are moving to our new headquarters on the University's Innovation Campus, designed to promote public-private R&D in areas related to food, water and energy.

Initially, our work is focusing on a few selected flagship programs aimed at increasing water productivity while at the same time ensuring sustainability. One of our flagship programs is the Global Yield Gap and Water Productivity Atlas, funded by our Institute and the Bill & Melinda Gates Foundation to map the difference between current average farm yields and yield potential along with estimates of water productivity (van Ittersum et al, 2012). We have joined with the Water Technology Center of the Indian Agricultural Research Institute in Delhi to develop a creative program of work centered on drought monitoring, irrigation efficiency, and improving drought and salt tolerance of crops. Last but not least, we have worked with the UNESCO-IHE Institute for Water Education in Delft, the Netherlands, to develop a pioneering dual degree Master's program that will begin to be offered as of September 2013 and will aim to train future innovators in water productivity and agricultural water management. In carrying out this work, we hope to provide important lessons on how University-based institutions can best be structured to contribute to the challenge of achieving more food security with less water.

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