Panelist Abstracts

Science and Technology Panel

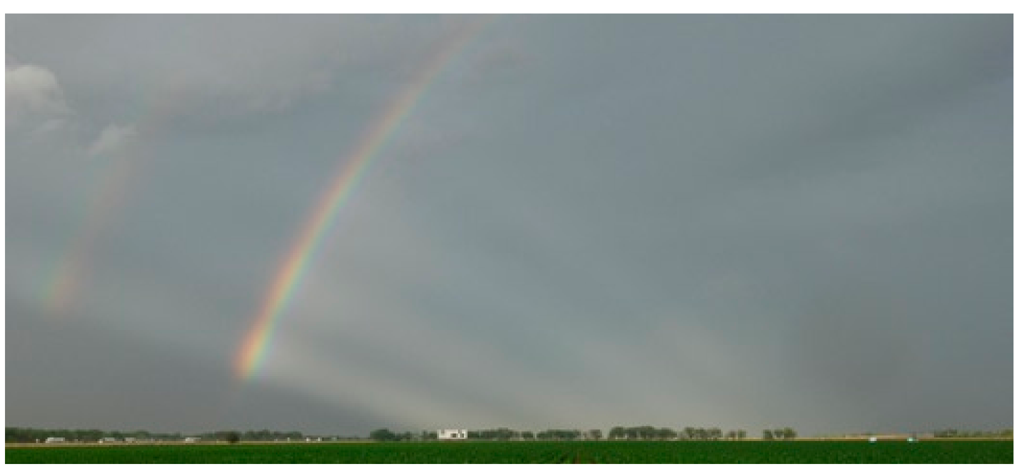
How Do We Grow More Food with Less Water?

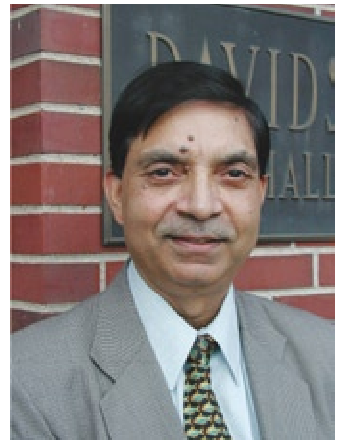
This panel will explore the key issues and challenges in the science and technology of water management for ensuring an adequate food supply for the world. The issues include assessment of water availability in the face of population growth and climate change, genetic development of new crops, technological and management practices to improve water-use efficiency, and management of agro-ecosystems to assure a full array of ecosystem services.

Moderator:

Sheri Fritz

Willa Cather Professor of Geosciences and School of Biosciences, University of Nebraska–Lincoln





Ramesh Kanwar

Charles F. Curtiss Distinguished Professor and Chair, Agricultural and Biosystems Engineering, Iowa State University

ABSTRACT

One of the fundamental questions for the global community is: How can we manage our available water resources and cropping systems to feed the growing population in the world in 2050?

For the past 25-plus years, total available agricultural land area per person worldwide has been decreasing and agricultural production systems are becoming highly intensive in order to grow more food on the same per unit area of land. This intensification in agriculture, especially under irrigated conditions, has brought water scarcity issues because of heavy pumping of finite groundwater sources and lowering of water tables in major aquifer systems in the world. In addition, intensification of agriculture has led to heavy use of agricultural chemicals, resulting in the degradation of surface and groundwater supplies and negative impacts on human health, making water quality a major public concern in the U.S. Build-up of soil salinity and land degradation are other emerging environmental quality concerns for farmers and policymakers.

In order to provide food security to a growing global population the final question is: What are the impacts of intensive agriculture and irrigation systems on the degradation of land and water resources and public health, and how can institutions of higher learning develop their research and educational curricula to train water professionals of the 21st century?

Brian A. Larkins

Porterfield Professor of Plant Sciences, University of Arizona; John F. Davidson, Ph.D., and Marian J. Fuller, Ph.D., chair in life sciences, University of Nebraska–Lincoln

ABSTRACT

Drought tolerance is an essential trait for plant survival as research has shown that it has a major effect on crop yields. Plants have evolved a variety of mechanisms for dealing with drought, including escape, various means of tolerance, and most importantly, ways of avoiding water deficit. Although plants share a number of common features and responses for dealing with drought, these mechanisms vary widely and reflect the environments in which the plants evolved. Drought tolerance is currently a major area of research, especially for seed and agricultural biotechnology companies. The goal of this research is to identify key genes and regulatory pathways that activate drought tolerance. To date, research has shown differences in the expression of hundreds of genes in response to drought conditions, which illustrates the complexity of the genetic regulation of this trait. Nevertheless, yield increases of 10 to 20 percent have been possible by expressing single genes in transgenic corn plants. Another approach is to take drought-tolerant crops, such as sorghum and millet, and engineer them to produce grain with the properties of corn and wheat. Research to produce high protein quality sorghum is very promising, as is the possibility of engineering sorghum flour to produce loaves of bread.

Judith C.N. Lungu

Dean, School Agricultural Sciences,
University of Zambia

ABSTRACT

Water in Zambia, like anywhere else in Africa, is a limited resource and must be carefully managed for the benefit of all people and the environment to ensure a sustainable food supply and security. On the other hand, over-exploitation of water resources, mainly for agriculture, has created environmental disasters. Efforts to provide adequate water resources for Africa face several challenges, including population pressure; problems associated with land use such as erosion and/or siltation; and possible ecological consequences of land-use change on the hydrological cycle. In addition, other emerging issues of climate change and vulnerability to global warming create huge impacts on both irrigated and non-irrigated agriculture. Understanding the characteristics of African climate allows for efficient and effective management of the water resources for present and future agricultural production. Agriculture contributes significantly to African national economies through employment and food supply. Water withdrawals from sources are mostly directed toward agriculture. In addition, Africa's climate has put pressure on agricultural development, as many African countries continue to be the lowest per capita energy consumers in the world, and energy is necessary for agricultural development.

The challenges faced by water resources are recognized as a serious global issue and Africa has to prepare initiatives in response. These include formulation of long-term water policies and related strategies, increasing water productivity, promoting water availability, controlling agricultural pollution, reforming institutions and management, enhancing stakeholder participation, raising awareness and developing information systems, developing human resources, supporting action-oriented research and adopting innovative technology. There also are opportunities, including increased water productivity in both rain-fed and irrigated agriculture; increased availability of affordable, environmentally acceptable water that generates maximum socio-economic returns; harnessing new water supplies; expanding storage capacity; empowering communities and user groups; ensuring access to food; reforming water management institutions; and making needed investments to develop surface and groundwater resources.

The priorities for Zambia must be consistent, comprehensive water and food policies, promoting equitable trade, expanding water storage and improving water quality. Water storage and harvesting techniques should also be further developed to enhance productivity in rain-fed agriculture, shifting the focus of irrigation development, making irrigated agriculture more productive, reforming irrigation and drainage institutions, developing information systems and knowledge networks, improving water education, building capacity and increasing research.

Vincent Vadez

Principal Scientist, Head of Crop Physiology Laboratory, International Crops Research Institute for the Semi-Arid Tropics

ABSTRACT

The International Crops Research Institute for the Semi-Arid Tropics, with headquarters in India and several regional stations in sub-Saharan Africa, has a mandate to improve five dryland crops: sorghum, pearl millet, groundnut, chickpea and pigeonpea. Improving the productivity of agro-ecosystems of the semi-arid tropics to improve the livelihoods of rural populations is at the center of ICRISAT's research. ICRISAT approaches the issue of water limitation with an integrated genetic and natural resource management paradigm, looking at the optimum combination of the right genetics and the right management to maximize the return (in grains or dollars) from a limited amount of water. To better understand the water limitation, the distinction of water into "blue water," which includes water bodies such as dams, tanks and ponds, and "green water," the water contained in the soil profile, is a useful way to distinguish the issues at stake.

With regards to "blue water," ICRISAT has an active community watershed program targeted to maximize water capture and to attempt to improve the small proportion (only 35 to 45 percent) of rainwater eventually used by crops. ICRISAT approaches include (re-)developing water tanks, promoting water harvesting technologies and advising on water-efficient crop rotations. ICRISAT also promotes the use of percolation tanks to promote groundwater recharge and collaborates with institutions that specialize in groundwater resources. ICRISAT also targets an enhanced return from that limited water (for example, by shifting to high-value crops).

With regards to "green water," ICRISAT looks at the genetics of crops that can maximize both green water capture and efficient use. An active crop improvement program involving biotechnology is working to harness superior rooting traits. In that respect, major efforts have been made on the methods and approaches to study roots, with a large facility that allows high throughput, precise and in-vivo assessment of root related traits. Similar work is ongoing to better understand the traits leading to higher water use efficiency of crops and to identify the genomic regions governing those traits. Work on water use efficiency of rainwater also is taking place at the field management level, for example, by ensuring proper fertility of agricultural land. ICRISAT has made major efforts with micro-dosing techniques, seed priming and seed pelleting techniques that allow the delivery of an affordable amount of nutrient to the seedling and lead to better crop stands and yields. ICRISAT also promotes soil water recharge by promoting land form treatments (e.g., broad bed furrow), landscape management (half-moons), or in-situ soil conservation (no-tillage, crop residue mulching). A socio-economic analysis also is carried out in parallel to assess the trade-off associated with the implementation of these technologies.

Ron Yoder

Head, Department of Biological Systems Engineering and Associate Director, Agricultural Research Division and Extension, University of Nebraska–Lincoln

ABSTRACT

Careful and expert management of water in agriculture is essential to ensure an adequate food supply for the world. By 2050, the world population is projected to be 9 billion, a 40 percent increase; the U.S. population is projected at 438 million, a 31 percent increase. Global estimates show that agriculture accounts for 66 percent of all water withdrawals and 86 percent of water used consumptively. In the western U.S, nearly 90 percent of water withdrawals are for agriculture.

Decision-makers and policy planners are challenged to analyze impacts of human and natural actions on the hydrologic system and to quantify the integrated effects of management decisions. Methodologies are needed to develop and assess alternative management practices for efficient water use with sustainable quantity and quality. Assessing future water uses in a changing world requires scientific advances to accurately measure water use and availability, evaluate the status of hydrologic systems, obtain reliable information on producer practices, quantify social and economic responses and develop models that reproduce observed patterns. Integration of science, technology, decision support tools and policy development and analysis is needed to address the challenge of decreasing water supplies in the face of increasing demand.

Nebraska farmers irrigate about 8.56 million acres (3.47 million hectares) with more than 9.5 million acre-feet (11.7 billion cubic meters) of water annually. Current irrigation demands and below-normal precipitation in recent years have contributed to reduced groundwater levels in some areas of Nebraska's watersheds, including parts of the Platte, Republican, Niobrara, Loup and Elkhorn river basins. Effective irrigation management technologies and strategies can conserve water resources through proper irrigation timing and amount. One project that is proving effective is the Nebraska Agricultural Water Management Demonstration Network, an on-farm extension initiative that produces irrigation water savings through implementation of in-field evapotranspiration and soil moisture monitoring technologies. More than 300 irrigators actively participated in 2008, reporting water savings of 2.6 inches (66 millimeters) for corn and 2.1 inches (53 millimeters) for soybeans. If 2 inches (51 millimeters) of water savings were realized on all irrigated area in Nebraska, the annual statewide reduction in irrigation water pumped would be 1.4 million acre-feet (1.72 billion cubic meters), and the potential reduction in CO_2 emitted could be 470,000 tons (426,000 metric tons), assuming diesel fuel was used as the energy source for pumping.

Panelist Abstracts

Policy and Human Dimensions Panel

The Costs of Water

The panel will discuss the effects of water and agricultural policies on freshwater supplies, food production and security, the environment and the socio-economic well-being of people at global, regional and local scales. Political, economic and legal challenges and opportunities for decision-makers will be explored.

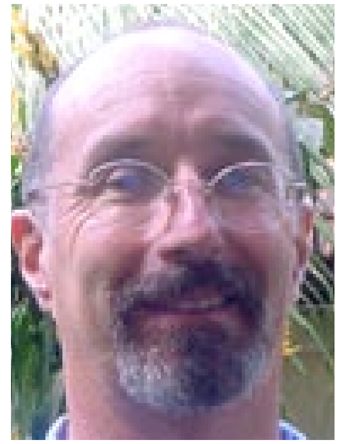
Moderator:

John Owens

Harlan Vice Chancellor for the Institute of Agriculture and Natural Resources, University of Nebraska–Lincoln and Vice President, University of Nebraska

Marc Andreini

Senior Researcher, International Water Management Institute



ABSTRACT

Africa has not made the progress toward feeding itself that was expected following independence; it is claimed that the Green Revolution has never occurred in Africa. A need to dramatically increase the production of staple foods remains, and policies must be implemented, institutions created and infrastructure built to provide what is necessary for Africans to feed themselves. To support smallholders and commercial farmers, sustainable supply chains must be developed, market access improved through regional integration and transaction costs lowered. A reliable water supply is of the highest priority.

Globally, there is a great deal of discussion about the need for increased water use efficiency, sometimes referred to as "more crop per drop." When viewed globally, it is estimated that water withdrawals for agriculture may increase as much as 17 percent in the next two decades. The question most often asked is "How do we allocate scarce water resources for agriculture, industrial and domestic use?" Yet in Africa, the problem is primarily one of wisely developing and exploiting the now under-utilized water resources. Much of Africa has extremely high variability in rainfall and river flow. In some areas, climate change appears to be shortening the growing season and making rainfall less reliable. The division of the continent by the colonial powers left Africans with several shared river basins, which complicates integrated river basin management. Coping effectively with variations in rainfall and river flows requires storage. North America has 6,150 cubic meters of storage per capita. South Africa has 746 cubic meters of storage per capita, and Ethiopia has 43 cubic meters (David Grey, 2002, AMCOW meeting presentation). There is a glaring lack of infrastructure to supply water for irrigation and other uses. Medium-sized, multiple-use dams and small reservoirs should be built and groundwater use should be expanded and managed sustainably. Developing a reliable water supply for agriculture will require capital, well-managed institutions and collaboration at national and international scales.

Sandra L. Postel

Director, Global Water Policy Project

ABSTRACT

It is time to face the music about the world's water and food dilemma. Demand projections notwithstanding, *less* water is likely to be available for food production in the years ahead, even as world population climbs to 1.2 billion by 2025 and at least that many people strive to move toward water-intensive North American-style diets.

Today, at least 10 percent of global food production depends on the unsustainable use of water. In India, where this figure may be closer to 20 percent, millions of tubewells have already gone dry, and in the Punjab, the nation's breadbasket, water tables are dropping pervasively and precipitously. In China, which has 20 percent of the world's population but only 8 percent of its renewable freshwater, falling water tables, the over-tapped Yellow River, and the reallocation of water from agriculture to urban-industrial uses will soon force the nation to enter the ranks of long-term net grain importers. Australia's prolonged drought in the agricultural heartland of the Murray River basin is curtailing grain production there, possibly for the longer term. And in the United States, ongoing depletion of the High Plains Aquifer, the over-appropriation of the Colorado and most other western rivers, and calls for ecosystem restoration will reduce water availability for irrigated agriculture.

On top of these trends, global warming and energy supply transitions are changing the long-term equation for water and agriculture. Glaciologists project that, within a few decades, the glaciers that sustain the rivers that irrigate crops for some 2 billion people in Asia will have largely disappeared. Mountain snowpacks will become less reliable suppliers of water during the irrigation season, as California growers are experiencing this year. Globally, as the climate warms, dry areas are projected to get drier and wet areas wetter. Much of drought-prone sub-Saharan Africa may dry out further. And a substantial share of the water consumed in agriculture could be dedicated to growing biofuel crops. Indeed, this year, a quarter of the U.S. grain harvest will be used not for food or feed, but to fuel automobiles.

A new agricultural water economy must be created that breaks out of compartmentalized boundaries and fully integrates the water-food-climate-energy-poverty-environment nexus. A core goal must be to at least double agricultural water productivity over the next 15 years – that is, doubling the benefit derived from each unit of water devoted to food production purposes. At the same time, policymakers and scientists must focus on adapting both irrigated and rain-fed agriculture to a warming, more drought-prone world; on expanding affordable, small-farm methods to alleviate hunger and food insecurity; and on harmonizing agricultural water use with the protection of ecosystem health and ecosystem services. On the consumer side, education and incentives must encourage healthy, water-thrifty diets.

Otto Szolosi

Irrigation Consultant and Former Lecturer, Charles Sturt University

ABSTRACT

Water shortage is a critical issue in most countries across the world. Growing populations and increasing necessity for food and industrial growth have amplified demand for water resources. Agriculture is the main user of water in most countries – using 70 percent of water withdrawals in Australia – and this sector is under increasing pressure. Future demand growth in other sectors, where water use generally has a higher economic value, will lead to increased pressure for reallocation away from agriculture.

Ten years ago we did not have a water shortage issue in Australia – we had only a water management problem. Ignoring this issue, Australians failed to make better use of water resources. With ongoing climate change, most now agree that water shortage is one of the biggest challenges facing the country.

In response to the above issues, the Australian government's framework "Water for the Future," issued in 2004, provided national leadership in water reform in order to secure water supplies for Australian households, businesses and farmers, as well as provide water to restore the health of Australia's stressed river systems.

"Water for the Future" is being delivered through a 10-year, $12.9 billion (AUD) investment in strategic programs, improved water management arrangements and a renewed commitment to deliver a range of water policy reforms in rural and urban areas. From a policy position, the Australian government has been developing management strategies and water markets to achieve the required social, environmental and economic goals.

"Water for the Future" programs have been developed to accelerate on-ground actions to improve water use, management and adaptation to climate change. Water trading aims to create open and competitive markets where water use is demand-driven rather than administered by governments and can deliver significant economic and water efficiency benefits.

Science is available but is unlikely to deliver the complexity of information rapidly enough to make the trade-offs and value judgments required in water use decisions. The National Water Initiative recognizes that water in Australia is managed through a combination of instruments/tools including market, regulatory and planning-based systems.

In conclusion, past experience and the ongoing projects prove that we can, and we must, make better use of our available water resources. This has to involve proactive cooperation between rural and urban communities, agricultural and industrial bodies, and local, state and federal governments. Managing our water to meet agricultural, urban, industrial, fisheries, community and environmental needs is the key to the future of all the countries.

Sandra Zellmer

Professor, University of Nebraska College of Law

ABSTRACT

Visitors to the Colorado State Capitol will see the phrase written on a panel in the rotunda: "Here is a land where life is written in water." The poet Thomas Hornsby Ferril wrote these words in 1940. Although the American West is experiencing dramatic demographic changes, with dwindling populations in many of its rural areas and rapidly expanding populations in Denver, Las Vegas and other western cities, Ferril's words remain as true today as they were then.

In the American West, agricultural uses comprise around 80 percent of all water withdrawals. With less than 5 percent of the West's population earning its living from agriculture, however, the day-to-day workings of ranches and farms that produce our nation's food are a mystery to most Americans. To many, water law may be seen as equally arcane and some might even argue archaic.

The western United States, like many arid regions, follows the law of prior appropriation to govern the use and allocation of surface water resources within states. Prior appropriation is a "first in time, first in right" rule that prioritizes senior uses. Agricultural uses are among the most senior uses in the West. So long as the use is deemed "beneficial," that is, non-wasteful in terms of both quantity and type of use, senior users are protected to ensure their full allocation of water, even if more economically or environmentally valuable junior users suffer.

Interstate and international water bodies, by contrast, are governed by a principle of "equitable apportionment," where prior use is a relevant factor but is not controlling. This doctrine reflects the bedrock principle of modern international environmental law that no nation (and no state) has the right to use its territory in a manner that causes injury to the territory of another. More specifically, equitable apportionment requires that trans-boundary waters be shared among riparian nations or states so that each may enjoy its fair share. The determination of a fair share is guided by a variety of factors, including: natural geographic, hydrographic, hydrological, climatic and ecological factors; social and economic needs of the riparian nations or states; existing and potential uses of the watercourse; the effects of the use of the watercourse in one nation or state on another; the availability of alternatives to a particular planned or existing use; and conservation and protection of water resources of the watercourse.

In part because of its flexibility, equitable apportionment is becoming an important aspect of regional stability and sustainable development. Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Specifically, as it relates to water, Agenda 21 of the United Nations Conference on Environment and Development declares the following objective: "To make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases. Innovative technologies, including the improvement of indigenous technologies, are needed to fully utilize limited water resources and to safeguard those resources against pollution."

Water law in the United States and throughout the world is situated on the precipice of a new era. The fundamental goal – that all persons have access to clean, reliable water supplies to satisfy fundamental human needs – has not changed. Yet as Agenda 21 acknowledges, innovative, collaborative approaches to water management will become ever more imperative. The need to identify and analyze both the obstacles and the opportunities posed by domestic and international water law, along with the potential for legal reform, has never been more compelling.