

Changing Challenges: Water, Food and Life

We've always known water is vital for survival, but in recent decades, water has become urgently important to the world in its relationship to food security. Nearly 70 percent of all fresh water extracted for human use is now used for irrigation, and researchers across the globe are working to improve food production while preserving and protecting water resources.

The challenges are many. Increasingly affluent populations demand new types of food in larger quantities. Agriculture causes unintentional pollution, water depletion and costly energy consumption. International crises block efforts to feed those most in need. Problem solving is hampered by poverty, border conflicts, terrorism, corruption, unbalanced access to resources, gender equality battles and financial roadblocks, among other things. Climate change is triggering longer droughts, violent storms and unusual weather patterns.

Many organizations, governments and businesses are taking action to mitigate these challenges. The Robert B. Daugherty Water for Food Global Institute (WFI) is one of the few university-based institutes in the world focused solely on the use of water for food. We are located in one of the world's major farm regions, in a state known for 150 years of agricultural, technological and institutional innovation. With a focus both on our state and the world, from the University of Nebraska's dynamic Innovation Campus, we are in a unique position to provide knowledge, expertise and support to many of the stakeholders and players in water and agriculture. When our world's population reaches a projected 10 billion in 2050, we believe we'll be ready.

CALLOUT:

According to the Food and Agriculture Organization of the United Nations, roughly 1/3 of the food produced in the world for human consumption every year gets lost or wasted, which means the water used to produce it — water that could be used to produce more food — is also wasted.

Editor's note: I took most statistics from WFI materials. I'm assuming you don't want to cite sources, since you didn't in the other pieces. Just in case you do, facts were obtained from the following resources:

1. According to the UN, nearly 70% of all freshwater extracted for human use is now used for irrigation: <http://water.usgs.gov/edu/wuir.html>, <http://www.globalagriculture.org/report-topics/water.html>, http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt254.pdf
2. "roughly 1/3 of the food produced in the world for human consumption every year gets lost or wasted": <http://www.fao.org/save-food/resources/keyfindings/en/>
3. "hundreds of billions of dollars wasted": <http://www.fao.org/save-food/resources/keyfindings/en/>

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If you think we need an "Introduction" -- perhaps this could be whittled down to 2-3 paras that briefly describe the challenge and introduce the Water for Food Global Institute and the Nebraska Water Center, then jump into the "Making a Difference" section.

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[graphics: this is a conceptual introduction, meant to set the mood for the annual report. The goals are to put the words into a graphically rich setting that takes the reader first to a philosophical—even emotional—understanding of the topic and the WFI's place in the world of water and food. In the pages that follow, having read this introduction should help the reader remain philosophical and emotionally ready to take in the details of what we achieved last year.]

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Nebraskans are determined, thoughtful, quiet, hardworking people. We are known for keeping our heads down and doing what it takes to get a job done. Over the past century, many of us have turned our efforts toward farming, because the land here is perfect for it. We've produced generations of crops — corn, wheat and soybeans among others — with great success. We provide more than xx percent of the United States' food export to countries all over the world.

If that's all you know about Nebraska, you might think we live in a temperate part of the world with generous rainfall, where we can produce multiple crops in a year. But that's not so. Nebraska is located in the middle of what is sometimes called The Great American Desert, a semi-arid land with harsh summers and winters that force us to irrigate only one crop a year in most cases. We have become very good at irrigating. In this one state, we pump water from the Ogallala Aquifer to more acres than all but 14 countries of the world. Yet, despite intensive irrigation, Nebraska's water table is at nearly the same level today as it was in the 1950s.

But farming isn't the only reason we are among the best water managers and agricultural producers in the world. For more than 150 years, the University of Nebraska has been fertile ground for innovative world-class water research, tools and policies that have had a tremendous impact on the world's water and food resources. Two generations ago, we devised a unique water management model that still works beautifully: Nebraska's Natural Resources Districts, drawn on natural, rather than manmade boundaries, which supports effective water management for both urban and rural needs.

In 2010, out of this rich water and agriculture heritage, came the Robert B. Daugherty Water for Food Global Institute, a vessel of knowledge, gathering up every drop.

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Preface

In its first five years, the Robert B. Daugherty Water for Food Global Institute established its roots through a period of aggregation and bridging. We gathered people, tools, research and partnerships we knew would help fulfill our ambitious vision. Then we connected those assets in ways that exponentially multiplied their value in our quest to meet the world’s rising demand for food with less pressure on its scarce water resources.

Last year, we used the infrastructure we had built to fuel dynamic advancements in water and food security within selected areas of the world.

We struck agreements with university faculty, worked alongside farmers, scientists and communities, and forged partnerships with key national and international organizations. Some of the world’s foremost experts now know of and are seeking collaboration with the institute to help them address their sometimes very grave need to optimize water use and food production.

Over the past year, among many other admirable achievements by our partners, research fellows and scientists, we logged successes in three especially notable areas. These projects are launched, funded and showing much promise.

- Our partnership with the Indian Agricultural Research Institute has gone beyond our expectations. We now have 10 PhD students working in Nebraska on some of the world’s most severe water for food challenges, using exciting new technologies.
- Our new work in the Middle East and Africa is advancing rapidly, addressing drought through the use of geospatial mapping and monitoring to improve irrigation management and crop productivity. This work is funded by the U.S. Agency for International Development in collaboration with the National Drought Mitigation Center at the University of Nebraska-Lincoln and the Dubai-based International Center for Biosaline Agriculture.
- WFI’s Water for Food Global Conference has come of age. The seventh conference, held for the first time at Nebraska Innovation Campus, included a wealth of associated high-level meetings and events, both before and after the main sessions.

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Woven through every goal we have achieved is the combined power of the Water for Food Global Institute and the University of Nebraska to fuel water for food solutions—the deep knowledge and innovation of our interdisciplinary team of scientists and practitioners, the exemplary management model inherent in Nebraska’s Natural Resources Districts (NRDs), and more than 150 years of real-world, high-productivity irrigation experience.

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Our greatest achievement may be something even more fundamental—the partnerships we have developed to help the world solve these daunting problems. Everything we have achieved is due to the passion and hard work of people who truly believe this is necessary and achievable work.

We could not accomplish what we do without dedicated researchers, scientists, farmers, university administrators and community leaders—both within Nebraska and globally. The institute also benefits from the longstanding leadership of the Nebraska Water Center, which became a part of WFI in 2012.

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Since 1964, the NWC has provided water management and quality research, teaching, extension and outreach throughout Nebraska, from the Missouri river to the Wyoming and Colorado borders.

When I was studying civil engineering as an undergraduate student, we were asked to choose a specialty: buildings, roads or water. I chose water, with no inkling how far this discipline would take me in my personal understanding of the world and the people in it. I learned from difficult experiences on the ground that water is absolutely vital to the well-being of humans—to our livelihoods, health, daily needs and policies. Perhaps most importantly, water is needed to grow the food that keeps us alive and makes everything else possible. During my time in Nebraska, I have strengthened my belief that human beings have the drive and talents to overcome these challenges.

As I prepare to leave the institute in the capable hands of incoming Executive Director Peter McCornick, I am filled with gratitude for those who have supported our efforts over the past six years, and I encourage my colleagues to continue leveraging the original endowment to build an ongoing network of supporters who will passionately continue to uphold this very worthy cause. We cannot forget the original foresight and generosity that made all of this possible through the Robert B. Daugherty Foundation endowment.

I have no doubt support of WFI here in Nebraska and across the globe will continue if the Institute and its partners insist that research and policy result in action. Action builds credibility, shows progress and inspires commitment. And therein lies the key to the ongoing success of the institute and its ability to contribute to solutions that create water and food security for the people of our world.

Roberto Lenton
Founding Executive Director,
Water for Food Global Institute at the University of Nebraska

~~2 CHANGING CHALLENGES 160725 1kf~~

~~3 WFI MAKING A DIFFERENCE 160725 1kf~~

[Rationale: Objectives of this section include 1) create an overview that hints at the depth of WFI's work if a reader only has time to read the first couple of sections of the report; 2) provide perspective on the WFI's growth and development in the last fiscal year; 3) provide context and perspective on the way WFI is helping meet the goals laid out in the previous section.]

Making a Difference: Conversations & Collaborations

Throughout the 2016 Water for Food Global Conference, as well as in numerous pre- and post-conference workshops, WFI leaders, conference partners, speakers and participants conducted conversations that likely will lead to innovative research, international exchanges and many project collaborations in the coming years and decades. The meetings were a fitting expansion of the conference's 2016 theme: Catalytic Collaborations: Building Public-Private Partnerships for Water and Food Security. (Read more on page xx.)

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¶ In 2015, the United Nations brought to a close its international "Water for Life" decade for action, but in 2016, the critical need to monitor, manage and use water effectively on a global scale is alive and well — and the need is increasing every day as the world rushes headlong to a population of nearly 10 billion by 2050. ¶

¶ We've always known water is absolutely vital for survival, but in recent decades, water has become urgently important to the world in its relationship to food security. This is in part because agriculture has required increasingly large quantities of water to irrigate crops. Nearly 70 percent of all freshwater extracted for human use is now used for irrigation, and researchers all over the globe are working to improve our ability to produce more food while preserving and protecting our water resources. ¶

¶ The challenges are many. A more affluent population is eating different types of food in larger quantities. Challenges connected to this relationship between water and food can be complex and formidable on many levels. For example, an increasing need for larger quantities of food is not only due to a rising population. The need is also greater because people in many parts of the world are becoming more affluent, and they are selecting different types of food in larger quantities per person. We are beginning to realize that the push for increased agricultural production could be causing unintentional consequences, such as pollution, water depletion and costly energy use. ¶

¶ On a world scale, many small water and food insecurity issues can add up to worrisome global trends, and international crises often block efforts to feed those most in need. On a local scale, the smallest issues can cause big problems, such as when irrigation activities drain a village's ¶

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Those conversations are at the heart of the work we do at the institute. If the world's water and food production specialists operated in isolation, we might never reach our mutual goal of global food security without detrimentally impacting the life-giving water resources we all depend on.

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Through the annual conference and in many other ways, WFI reaches out to the world to find partners who will help fuel real change. Within Nebraska, WFI carries out its programs with the strong support of the Nebraska Water Center and the NWC's Water Sciences Laboratory.

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In fiscal year 2016, we moved beyond the infrastructure and bridge building stages of our early growth, and entered a new era of conversations designed to precipitate action. In all four areas of WFI's expertise and emphasis, we have made important strides toward fulfilling our mission: to have a lasting and significant impact on achieving more food security with less pressure on scarce water resources.

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WFI has a presence now in some of the most water- and food-compromised regions of the world, thanks to cutting-edge satellite-based technology used by University of Nebraska researchers to create innovative agricultural and water preservation tools. In partnership with the FAO, in the Middle East and North Africa (MENA), we are working to **close water and agricultural productivity gaps** through the development of a global public database that will help farmers improve yield, and at the same time help monitor drought and drive an early warning system. We are pursuing similar goals in India with the Indian Council of Agricultural Research, one of the largest and most influential agricultural organizations in the world. (Read more on page [xx](#).)

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We are extending the power of Nebraska's groundwater knowledge through participation in an important study of federal conservation policies on the High Plains Aquifer with the USDA's Agricultural Research Service and the U.S. Geological Survey. Meanwhile, we are **improving groundwater management for agricultural production** by developing the inaugural Nebraska Water Productivity Report and sharing the local lessons of the state's NRDs in the form of recorded interviews that can be accessed anywhere in the world. (Read more on page [xx](#).)

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With the international aid organization World Vision International and Valmont, the world's leading center pivot irrigation company, we are **enhancing high productivity agriculture** in a breakthrough center pivot project in Tanzania that has the potential to transform the lives of smallholder farmers, while helping the country feed its people for generations. Our collaboration in India with Jain Irrigation, one of the largest irrigation and food processing companies in the world, will help us develop salt and drought resistant crop varieties, advance the education of Jain scientists and expand the use of geospatial technology to improve irrigation water management.

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Farm fields are not separate from the ecosystems they exist in or the people around them, so we are working in a number of ways to study and protect **freshwater and agricultural ecosystems and public health**, from chronicling the movement of water in the Platte River Basin and educating the public through water-themed art to studying the motivations and habits of major water and food program contributors around the world. In this, we are fortunate to have as our permanent partner the Nebraska Water Center, as well as several Faculty Fellows working in Ethiopia, Chile and India. (Read more on page [xx](#).)

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From the Republican River Valley in Nebraska to the Mekong Delta in Vietnam, WFI is creating **on-the-ground** impact. We help the world best by leveraging **experience, resources, history and ideas**

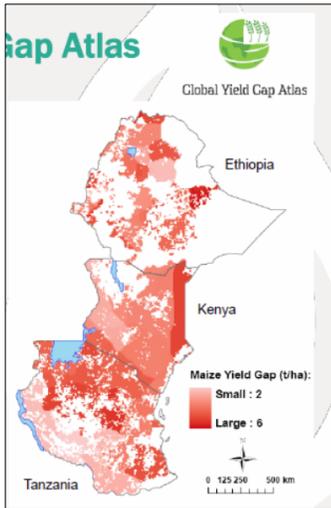
right here in one of the world's best natural laboratories for irrigation, groundwater and freshwater ecosystems.

3A Closing Productivity Gaps 160725 1kf

Closing Water and Agricultural Productivity Gaps

The Robert B. Daugherty Water for Food Global Institute builds on the pioneering work of the Global Yield Gap and Water Productivity Atlas, as well as the University's expertise in plant breeding and biotechnology development, to reduce productivity gaps in crop and livestock systems.

Closing the gap between actual and potential agricultural production is becoming a reality, thanks to production of a new satellite-based geospatial mapping tool using technology developed at the University of Nebraska and funded by the FAO. The tool measures evapotranspiration, the movement of moisture from the earth's surface to the atmosphere through combined evaporation and plant transpiration. It assesses the need for irrigation and calculates potential and attainable crop yield at three levels: farm, climate zone and country.



This tool is being activated right now by WFI and others in one of the world's most tenuous water and food security regions: the Middle East and North Africa (MENA). In a five-year project that began in 2015, the evapotranspiration products are being produced and served through the FAO's collaborative network in the region, with the involvement of government institutions and regional/local water and agricultural agencies to deploy the products on the ground.

The complex challenges of this project range from gaining field access and training farmers to extensive capacity building with local organizations and overcoming political and social barriers. The ultimate goal is to create a continually-available data system used by all countries of the world to improve water and crop management and support water and food security well into the future.

In 2015, WFI and FAO published a joint global yield gap analysis report reviewing methods for analysis and clarifying definitions and techniques to measure and model potential yield using biomass production and the FAO's harvest index. In fiscal year 2016, the contract was signed and a successful kick-off meeting was held in Cairo, Egypt, with participants from all countries in the region. The project began in earnest last January. In March 2016, the science working group for the project's water productivity sub-tasks met at WFI offices in Nebraska to discuss methodology and use of the evapotranspiration product.

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These what-ifs are

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In fiscal year 2016, WFI contracted with the University of Maryland to generate satellite-based estimates of daily evapotranspiration. It is expected to go public the first part of 2017, with the ALEXI water and energy budget model running on the UNL Holland supercomputing center.

The same tool is being used to monitor drought in the MENA region and provide an early warning system that will help farmers and governments make effective decisions, including determining where agriculture production can be intensified without risk to water resources. WFI and the National Drought Mitigation Center at UNL are co-leading a \$4 million, one-year drought monitoring project with the Dubai-based International Center for Biosaline Agriculture (ICBA).

The next steps in fiscal year 2017 for both crop yield improvement and drought mitigation are ground truthing in MENA fields and verifying the evapotranspiration product, downscaling for remote sensing in selected agricultural regions, and then estimating water productivity in the first selected regions: Morocco, Tunisia, Lebanon, Jordan and Egypt.

A central instrument of all of these initiatives is the USAID-funded graphically intuitive Global Yield Gap and Water Productivity Atlas (GYGA), which was developed by an international team led by the University of Nebraska with WFI support in the United States and Wageningen University support in The Netherlands. A science meeting was held with all partners at WFI in March 2016, where a goal was established to work toward adding 20 more countries to the 30 already incorporated into the atlas.

Currently, the atlas focuses on estimating crop yield gap for eight crops at field, regional and national scales, ranging from subsistence crops in sub-Saharan Africa to high-yield irrigated corn in the United States. More than a million visitors have viewed public data on the GYGA website (yieldgap.org). The atlas is used not only by researchers, but by crop consultants and commercial crop producers who want to benchmark themselves against the data-backed yield gaps in their regions.

"Our aspiration is to have complete global coverage of all global farmland. To feed billions in the future, we need to have not only the knowledge, but also the know-how."

—Kenneth G. Cassman, GYGA Project Leader

MENA isn't the only region where there is a critical need to close the gap between water and agricultural productivity. Last year, WFI and the University of Nebraska continued work under a 2013 Memorandum of Understanding (MOU) with the Indian Council of Agricultural Research to collaborate with one of its four institutes to create solutions for Indian agriculture and natural resources management.

Our partnership with the India Agricultural Research Institute (ARI) is an excellent example of expanding WFI's reach through strategic partnerships, with the ultimate goal of producing impacts on the ground. India is an ideal place to study and test our ideas and methodologies, because it has both a very large population and many challenges in the supply, management and use of water to produce food. In addition, India is one of the University of Nebraska's key partners for global engagement on many fronts, including agriculture, early childhood and public health—all areas affected by water and food security.

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Last year, The U.S.-India Educational Foundation in Delhi approved WFI's proposal to the Indo-U.S. 21st Century Knowledge Initiative competition to support the first initiatives of the partnership: an agricultural drought monitoring and early warning system, satellite-based evapotranspiration estimates, and water-conserving sensor-operated irrigation systems. The grant will help advance the MOU, as well as WFI collaborative programs in India as a whole.

How will we measure progress closing the yield gap with these efforts? WFI is producing what will be the first in a series of water productivity reports focusing on this question. The Global Water Productivity Report will define and test methodologies to determine gaps between actual and attainable water and energy productivity in both crop and livestock production.

Work on the report began this fiscal year with a pilot demonstration project of the methodologies and indicators for Nebraska farm, watershed and state scales, identifying the best management options associated with the maximum attainable water productivity level. Postdoctoral researchers have been hired and are establishing details of the method to be used for water productivity assessment. Once the methodologies and results are vetted within the Nebraska pilot, lessons learned will be used to develop global water productivity indicators and offer the benefits of gap analysis to the rest of the world.

3B Improving Groundwater 160725 1kf

Improving Groundwater Management for Agricultural Production

The Water for Food Global Institute draws on the vast experience of Nebraska's water governance institutions and farmers, focusing on scientific and policy research to improve understanding of the human and natural dynamics of groundwater.

If the High Plains Aquifer was surface water, it would be a geographic feature astronauts could see from space. But it's not surface water; it's groundwater—the unseen source of 30 percent of the water used for irrigation and animal production in the U.S., and the household water supply for millions of people living in the High Plains. It also has become one of the world's best and most productive laboratories for study of the water-energy-food nexus, a natural condition of interdependence and competing interests that helps us understand, respect and best manage these three basic resources.

The water, energy, food nexus represents a critical balance of resources. Consumption of all three elements is rising substantially with every passing year. Food security for a growing world population will require that the world produce 60 percent more food by 2050. Doing that will require a projected 10 percent increase in global water withdrawals, according to FAO. At the same time, global energy consumption is projected to grow by as much as 50 percent by the year 2035.

WFI is working on a pilot project that could help improve the world's balance of water, energy and food. With assistance from Arable, a manufacturer of smart meters that measure the use of both water and energy in one pump, WFI plans to design and deploy a network of pumps throughout Nebraska to

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¶ The relationship between water, energy and food is the crux of nearly every activity WFI undertakes. The

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¶ Although water is a natural resource, the potential imbalance of water, energy and food is a human-made problem, brought on by, of all things, success: population growth, urbanization, introduction of new foods through worldwide trade, increased use of technology, and many other advances. It's a human-made problem that demands a human solution. ¶

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gather information that can help manage irrigation systems more efficiently. We will provide the information to farmers, so they can make better decisions impacting the food supply, water supply, energy grid, their own profitability and their way of life.

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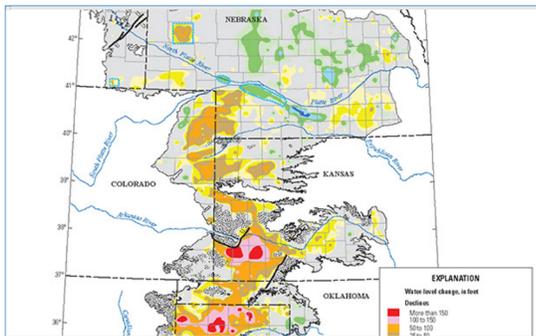
Here's one example of the power this knowledge can have: Let's say energy is highly subsidized by the government in a specific region. If water is cheap to pump, producers are not likely to be concerned with maximizing the use of water and may tend to overuse water, which could rapidly deplete groundwater supplies, reducing water availability for farmers, urban dwellers and the environment. A smart meter would help quantify the amount of energy a farmer is using – and paying for – and improve the region's ability to set policies that protect water resources.

"Energy is underappreciated as an aspect of ag production. When you look at groundwater use by farmers, they aren't paying for the water, they are paying for energy to pump the water. To understand how to best use water to produce food, we have to understand the competing interests between water, energy and food production."

--Nicholas Brozovic, WFI Director of Policy

A smart meter is an excellent tool to optimize the food-water-energy nexus. It reflects the interrelatedness of resources and helps avoid or mitigate the downstream consequences of overpumping. A smart meter can be a critical tool for individual producers who are making decisions about their own fields, for researchers seeking global solutions, or for those who set local, regional or national policies.

Last year, WFI received one of the largest grants it has ever received from the Agricultural Research Service of the USDA to begin a groundwater project with national policy implications. We will be collaborating with researchers at the USDA and USGS to analyze the impact of federal conservation policies on aquifer conditions across the High Plains Aquifer, of which the Ogallala Aquifer is a part. The plan is to use integrated hydrologic and economic modeling to estimate where and how aquifer depletion will occur in the coming decades, and determine whether policy interventions can help.



The project is focused on whether federal water policies and programs, such as the Conservation Reserve Program, have unanticipated impacts on the aquifer. The Conservation Reserve Program helps farmers take highly-erodible, environmentally sensitive cropland out of production by converting it to native grasses, shelter for wildlife, windbreaks and other uses.

WFI is contributing agricultural engineers and economists to the

project, while USGS is supplying hydrologic data and the USDA is delivering farm program data. This is one small part of understanding the water-food-energy nexus that might apply to policymaking worldwide.

Because of Nebraska's more than 150 years of experience managing major groundwater resources, and because the unique policies and groundwater management methods used by the state's natural resources districts (NRDs) have been so successful, visitors from all over the world are increasingly

looking to Nebraska agricultural producers, the NRDs and the University of Nebraska for methods of groundwater management as they relate to food production and other concerns. The NRDs, which are responsible for the state’s groundwater quality and use, are especially interesting to international visitors because the districts’ boundaries based on hydrological boundaries within the state in a bottom-up management model that prioritizes the natural resource over politics. In FY2016, WFI collaborated with the NRDs to host a number of international delegations.

Last year, WFI also finished work on a project with the Nebraska State Historical Society and the Nebraska Association of Resources Districts (NARD), designed to tell the story of the NRDs to help preserve the methods and policies that have made them successful. The NRD Oral History Project, now online at nrdstories.org, is comprised of more than eighty 45-minute recordings of former and current staff and leaders from all 23 districts, as well as key individuals who helped ensure their formation.

“We can develop all the research in the world, but in the end, if you don’t work to make policies and connect that to the people who produce the food and consume the water and get their buy-in, then all the research is for naught.”
---Jesse Starita, WFI Education Outreach Associate

The stories share not only what NRDs accomplished, but also the tension and friction that come with creation of a new set of rules for water use. Accounts of how the NRDs overcame those challenges are shared to provide a roadmap for regions facing similar challenges. A key takeaway from the project is the idea that achieving sustainable use of water and natural resources management takes a great deal of work by a lot of people. For newcomers to water resource management, the NRD stories provide confirmation of the importance of organized groundwater management — even if you can’t see it from space.

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Commented [KF19R18]: Not sure what report...can you provide information or a source?

3C Enhancing Irrigated Agriculture 160725 1kf

Enhancing High Productivity Irrigated Agriculture

The Robert B. Daugherty Global Water for Food Institute at the University of Nebraska works in partnership with the private sector, NGOs and social entrepreneurial groups to provide research, technology transfer, education and outreach to further the goal of increasing water productivity in all forms of irrigated agriculture.

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Nick said he doesn’t believe we need to mention the Water Productivity Report in this section, so I didn’t include it. Is this correct, or do we need to find a way to incorporate it?

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Tanzania is home to spectacular Mount Kilimanjaro and the Serengeti plains, attractions that draw visitors from all over the world. It is also farm country: 73 percent of men and 81 percent of women work in agriculture, producing food for a nation where the population has tripled in just 40 years. Like others in sub-Saharan Africa, Tanzanian smallholder farmers are stuck in a cycle of poverty and achieve four to 10 times less yield per acre than their commercial counterparts. It doesn’t help that shifting land use has decreased plot sizes, access to markets is limited, and rainfall is increasingly erratic.

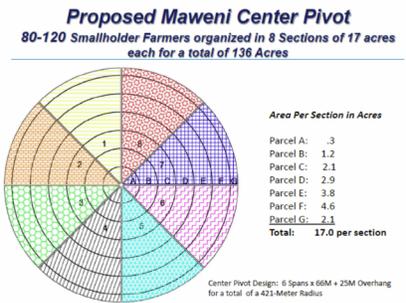
Commented [DL23]: Maybe some of these statistics would work better as sidebar infographics than part of the narrative.

Commented [MN24R23]: I like that idea.

Against that backdrop, on a continent where smallholder farmers produce between 70 to 90 percent of the food supply, the most welcome attraction in Tanzania may soon be a single transformative center pivot irrigation system. In partnership with Valmont Industries, Inc. and World Vision, last year, WFI launched a five-year pilot project, called CIRCLES, to test whether highly-mechanized and efficient irrigation systems already working in Africa for large food producers can be used to support smallholder farmers within a cooperative. Instead of one farmer or company owning many pivots, as many as a hundred people will farm small plots under a single pivot.

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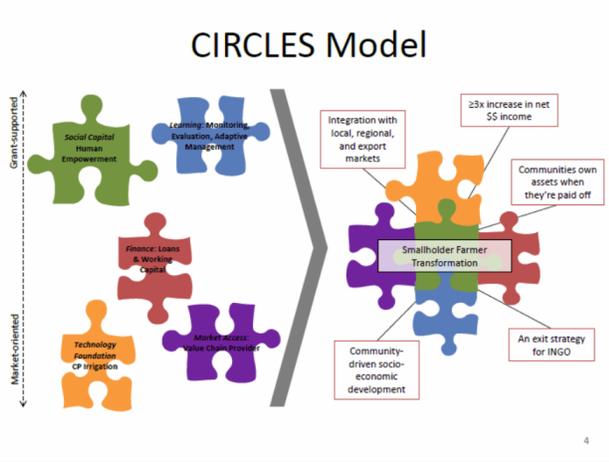


[caption:]
An earlier-identified plot in Maweni would have been divided into eight 17-acre plots for the use of smallholder farmers. This plot has been abandoned for now due to soil and land tenure disputes—an example of the challenges that often must be faced before progress can be made.

The project aims to show how smallholder and subsistence farmers can use center pivot irrigation and technical support to introduce high value crops, such as fresh vegetables, and gain better access to markets, with the potential to raise incomes of smallholder farmers from between one or two dollars per day to as much as \$6 per day. We anticipate that crop revenues will allow the farmers, as a group, to own the center pivot technology and operate independently within five years.

The CIRCLES intervention will positively impact much more than crop production. While farmers are pumping water out of a deep aquifer to supply the center pivot, they can also provide a village cistern, for example, which would allow women and girls to spend less time fetching water and more time on education and nutrition, which could elevate economic, social and health indicators in the region.

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 The graphics and quotes need some attention, to make sure they are fresh. I realize that these are probably just placeholders, but the Yield Gap map was prepared several years ago and should be replaced by something reflective of the 2016 work. Likewise, the CIRCLES model on page 13 was prepared in early 2014 and is anyway far too complicated. And we already used Christopher's quote on page 13 in the five-year report and should not repeat it here.

Last March, a team from the University of Nebraska Medical Center's (UNMC) College of Public Health visited World Vision staff in [Tanzania](#) to coordinate future field activities as part of the CIRCLES project. They conducted a baseline field survey and will follow the intervention for five years to determine how the indicators change.

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WFI recently identified a suitable 3,280-acre tract on Tanzanian land belonging to the Nelson Mandela Institute of Agriculture, Science and Technology. The WFI director of research is working with project partners on the final elements of the physical evaluation process, including digging an observation well to make sure there are enough water resources to support a large pivot. At the same time, the institute is developing a relationship with the area university to extend our work with the pivot and community for a 25-year period, the lifespan of a typical pivot irrigator.

Commented [DL26]: Need a new quote from Christopher regarding the CIRCLES project as this appeared in the 5-year report.

"Only four percent of African agricultural land is irrigated, compared to 20 percent of the world's agricultural land. With even drier conditions predicted in the foreseeable future, the need is only going to become greater."
 --WFI Director of Research Christopher Neale

To ensure the project has commercial viability, Great African Food Company (GAFCO) has joined with Quality Food Products Ltd (QFP) to drive the pilot test forward with business discipline and speed. Our hope is that the CIRCLES irrigator project is the beginning of several similar projects resulting in on-the-ground impact around the world.

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Improving access to equipment, training and techniques can make a difference, not only in food production, but in quality of life, for millions of smallholder farmers throughout every country in the world.

In India, WFI is working with a private corporation to achieve advancements in research, training and outreach to smallholders. Jain Irrigation Systems Ltd. is one of the largest international irrigation and food processing companies. It has created a business model that brings benefits to the company, but also helps smallholder farmers grow sustenance crops and feed their families through ~~small~~-scale drip irrigation systems.

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[photo]
BHAVARLAL HIRALAL JAIN
Founder and Chairman of Jain Irrigation Systems, Ltd., Gandhian and philanthropist, Founder of Gandhi Research Foundation, Philosopher, Writer, Advocate, Industrialist, Social Activist, Philanthropist, Farmer, Entrepreneur, Green Revolutionist
December 12, 1937 – February 25, 2016

In a joint international research and education partnership, WFI and Jain Irrigation will collaborate on scientific exchanges to improve water management and crop yields, help educate future scientists, and add value for smallholders.

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In fiscal year 2016, ~~a~~ new Memorandum of Understanding was signed by the leadership of Jain Irrigation, the University of Nebraska and the Water for Food Global Institute. ~~Once the grant is received from Jain Irrigation,~~ work will begin in a number of areas, including improving crop water productivity and water management using geospatial technologies, as well as improving drought tolerance using accelerated plant breeding through phenogenomics.

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The university's work in geospatial technology using satellite-based GIS and satellite image inputs to produce evapotranspiration estimates, drought early warning systems and water-conserving sensor-operated irrigations systems are ~~some~~ of the technological aspects of the partnership. Jain scientists will come to Nebraska to train at UNL's new Fast Phenotyping Facility, a state-of-the art laboratory and ideal environment for agricultural biotechnology training.

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WFI is taking Nebraska's irrigation expertise to Brazil where the main crops are maize and soybeans, with dry beans as a third major crop. Nebraska farmers can only produce one crop a year because of winter, but in Brazil they can plant and grow all year, producing through two-and-half crop cycles.

The institute is interested in acquiring data from the ~~Company Name's~~ more than 2,300-pivot irrigation system to help us understand costs of production and levels of water productivity in comparison to the same commodity crops grown in Nebraska. The company will provide agronomic and irrigation scheduling services and energy management. In return, we will share our knowledge of satellite-based remote sensing technology for pivot irrigation systems and teach them how to use it.

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Typically, center pivots and other irrigation systems are managed for maximum yield, but they ~~also~~ can be managed for maximum water and energy productivity. The farmer's goal is to use irrigation as effectively as possible to produce the most food with the least amount of inputs. The missing piece is the cost of energy, and this project will help us incorporate that information into other water, energy, food nexus considerations—not only as it impacts irrigation, but also other pieces of the water and food security puzzle.

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Freshwater and Agricultural Ecosystems and Public Health

The Water for Food Global Institute works to ensure that efforts to improve water and food security also advance public health and protect ecosystem integrity, while advancing the university's expertise in natural resources management, water quality analysis and public health.

Even as the Water for Food Global Institute works to close productivity gaps, improve groundwater management for agricultural production and enhance high productivity irrigated agriculture around the world, we realize we must also protect public health and ecosystems. The use of water to grow food is permanently intertwined with the use of water for many other purposes, including nutrition, health and hygiene, natural habitats, and recreation.

The **Nebraska Water Center (NWC)**, well known for its work in water research, teaching, extension and outreach, is a vital resource in advancing research involving public health and ecosystems. The center was initially mandated by the United States Congress in 1964 as one of 54 national Water Resources Research Institutes. More than 50 years later, the fundamental goals of the center haven't changed. The NWC helps arrange research to address water problems and supports educational efforts to help the world understand water and related issues.

NWC projects include training future water researchers and engineers, publishing research results and disseminating information about water through publications, presentations and tours. The center has helped establish the University of Nebraska's international leadership in water science and management.

Highlights of the NWC's work last year included its annual Water Symposium, "High Plains Aquifer: Sustainability for Food Production and Water Supply." Symposium workshops, held on campus at the University of Nebraska, addressed aquifer science, assessment, management, innovation and use—both now and into the future. In July 2015, NWC conducted its annual Water Tour. More than 70 participants explored the Republican River Basin from Nebraska into eastern Colorado, and a more than 75-year-old water compact between three states.

NWC's research and education efforts enhance the work of the Water for Food Global Institute. In the last fiscal year, with the Institute of Agriculture and Natural Resources at the University of Nebraska—Lincoln, WFI and NWC were awarded a \$10 million grant from the U.S. Department of Agriculture National Institute of Food and Agriculture. The grant will be used to address agricultural sustainability on the High Plains Aquifer, which accounts for nearly a third of total crop and animal production in the U.S. More than 90 percent of the water pumped from the aquifer is used for irrigated agriculture.

This work is important to the broad region served by the High Plains Aquifer in the face of climate changes and groundwater declines in some areas that could indicate a path toward unsustainability and exacerbate water competition between urban and rural users. The regional issues and potential solutions we discover also could have far-reaching impact on the way aquifer water is managed and used throughout the world.

[transition to global project?]

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[transition back to Nebraska projects?]

In the last few years, the institute provided support for the Platte River Basin Time-lapse project, which follows the Platte River from its source in Colorado to the mouth of the Missouri. WFI's funding in fiscal year 2015 was used to hire five interns to help create time-lapse videos at 50 camera sites along the river.

Another project supported by WFI is examining the way international actors have responded to global water crises, how they choose projects and partners, and how funding flows. In February 2016, Faculty Fellow Patrice McMahon traveled to Ethiopia to interview officials from international and local NGOs involved in the country's water crisis. The result of this work will be an open database of officials involved in water security in Ethiopia.

"Many global water actors are nongovernmental organizations (NGOs) and foundations. Why is this, and what do we know about the effectiveness of transnational water actors?"

--Patrice McMahon, WFI Faculty Fellow and Associate Professor in the University of Nebraska-Lincoln Department of Political Science

An important example of WFI's commitment to the protection of freshwater ecosystems and public health is our support of the Nebraska Watershed Network, developed by Faculty Fellow Alan Kolok, professor at the University of Nebraska-Omaha. Kolok works in conjunction with local stakeholders to advance environmental stewardship of freshwater resources and biota supported by those waterways. He and his team are currently involved in a number of local, national and international outreach, educational and research activities. In an interesting twist on water education last year, Kolok led a collaboration producing creative water exhibits for KANEKO, a museum in Omaha, Nebraska. The exhibition was the focus of an article in Smithsonian Magazine.

"Virtually anyone with a smart phone can gain access to the best information possible, so they can be involved in the process of making decisions for their community. They can have a hand in this work virtually every single step of the way."

--Alan Kolok, Director of the Nebraska Watershed Network and Interim Director of the Center for Public Health and Toxicology at the University of Nebraska Medical Center

In addition to his watershed work, Kolok is interim director of the Center for Environmental Health and Toxicology within the College of Public health at the University of Nebraska Medical Center. The double emphasis of Kolok's work allows him to effectively research and examine the connection between efficient production of food and potential adverse consequences. Much of Kolok's work involves empowering citizens, both in Nebraska and internationally, to become involved in the decision-making and data collection process—to accept a role in the protection of ecosystems and public health.

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Education and Engagement

The Water for Food Global Institute is committed to teaching, and engaging with scientists, students, faculty, farmers, policymakers, non-profits, non-government organizations, private producers, media and

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Commented [DL36]: Per Roberto: I think it would be better to separate out the education, conferences/workshops, and communication activities into three separate sections. That would enable the report to do full justice to the significant work accomplished during the last year in each of these three areas.

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the general public to educate, inspire, connect and collaborate our way to greater water and food security for the world.

WFI's research and policy work is advanced when scholars and policymakers teach others what they have learned. Ideas are turned into action as water managers collaborate with agricultural producers. Agriculture and water education creates commitment and engagement among faculty and students who could become the next generation of water for food advocates. These are just a few of the ways education and engagement connect many small conversations and combine them into big impacts.

It doesn't happen overnight, of course. During the six years of its existence, WFI has cultivated educational experiences with many individual partners and stakeholders. In fiscal year 2016, the institute engaged in conversations and collaboration with a wide variety of audiences, including the general public, engaging larger audiences and providing opportunities for everyone to contribute. WFI outreach includes conferences, workshops, international exchanges, study tours, research forums and roundtables.

The institute's largest educational event is the Water for Food Global Conference, held in Lincoln, Nebraska, where WFI headquarters is located. The Nebraska location provides easy access to many water and agricultural experts, as well as private producers on the front lines of water management and food production.

Last year, more than 350 participants from around the world attended the conference, including 60 speakers discussing various aspects of science, technology and policy addressing one of the most urgent challenges of the 21st century: how to achieve greater food security with less pressure on water resources. Conference attendees and speakers collectively provided a 360° view of this intractable challenge.

The theme of this conference was "Catalytic Collaborations: Building Public-Private Partnerships for Water and Food Security." Nebraska Innovation Campus was a perfect setting for collaboration, with attendees representing both public and private enterprises: engineers, plant physiologists, corporate CEOs, researchers, entrepreneurs, agricultural economists, philanthropists, private consultants, leaders of distinguished foundations and many others with the credentials and desire to tackle the challenges of water and food security.

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Additional collaboration took place in pre- and post-[conference](#) meetings, focusing on the role of expanding irrigation for smallholder farmers in sub-Saharan Africa and on advancing Big Data in agricultural production.

Distinguished guests attending the conference included members of the institute's International Advisory Panel, who held their annual meeting before the conference to provide guidance to the institute's leadership on research, policy, communication and education programs.

The Water Advanced Research and Innovation (WARI) Fellowship Program

[WARI is a joint initiative of the Department of Science and Technology \(DST\), the government of India, the University of Nebraska-Lincoln, the Robert B. Daugherty Water for Food Global Institute and the Indo-US Science and Technology Forum. The program is designed to bring high-quality Indian Ph.D. students and early-career faculty to Nebraska to carry out research in water science and engineering.](#)

[In fiscal year 2016, applications were solicited and the first 12 participants were selected from a pool of 79 applicants. The way had been paved by a reception in Washington, D.C., signaling the launch of the new program, and two visits to India by WFI representatives. A reciprocal component of the program funded by DST and UNL will allow U.S. students to visit India for collaboration with Indian water scientists.](#)

EPA Water Quality Trading Workshop

Water quality trading is a relatively new activity that enables polluters to meet regulatory obligations by purchasing equivalent or larger pollution reductions from another source. They also can meet obligations by protecting or restoring water sources to reduce the impact of pollutants.

A significant conference [last year](#) on water quality trading co-hosted by WFI, USDA and EPA brought more than 200 state government and private sector attendees to Lincoln to discuss what works, what doesn't, and next steps. There is growing interest in a water quality market, but it could be difficult to implement. The conference speakers and participants shared their experiences and ideas for using water quality trading to advance water for food security.

UNESCO-IHE/University of Nebraska Double Degree Program

"Water is becoming more recognized as a central component to many of the world's complex challenges. That breadth speaks to the importance of multi-sectorial partnerships. WFI is well positioned to help catalyze those collaborations on local and global levels."

--Peter McCormick, WFI Executive Director-Elect

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¶ With programs that last 3 months, internships that can last as long as 6 months, and fellowships that can continue for 12 months, one lasting benefit of this program is its potential to connect next-generation scientists from India and the United States with each other, developing relationships and collaborations for research and development that might never have happened without the program, and are likely to continue well into the future. ¶

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This masters-level double degree program combines the University of Nebraska's agricultural setting and expertise with the experience of The Netherlands' UNESCO-IHE water education facility in educating people of the developing world. Program candidates must have three years of professional experience to be considered for the program, and earn a master's degree from each institution.

"In all my years at the university, the students working in this program are the most eager learners I have ever run across."

--Dean Eisenhower, Coordinator of the UNESCO-IHE Partnership, WFI Faculty Fellow and Professor Emeritus of Biological Systems Engineering

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The first two participants in the program graduated in 2015. Two more have begun the process. Mumba Racheal Mwape is an irrigation engineer from the Zambia Ministry of Agriculture. She began her study in Nebraska, then returned to Zambia to gather data, and will come back to Nebraska write her thesis here, with a graduation target of May 2017.

Xxxxxx xxxxxxxx is a hydroinformatics student from Milan, Italy. He began his studies at IHE and will travel back and forth twice before graduation in the summer of 2018. Joint advising will help this student reach the level of expertise he wants in this relatively new specialty, which applies information technologies to water-use problems.

In the coming year, WFI will welcome other IHE master's students for a two-week, hands-on field course in Nebraska. Access to Nebraska's irrigation industry and water resource management agencies helps students learn measurement methods.

Jordan Study Tour and Syrian Crisis Conference

The relative stability of the desert kingdom of Jordan defies its location. The country shares borders with Saudi Arabia, Iraq, Israel and war-ravaged Syria, and has become home to as many as 1.4 million Syrian refugees. Arid Jordan struggled with food security before the refugee crisis, so it has become a great challenge to feed its refugee population. Four undergraduate University of Nebraska students and three WFI members examined this problem in a week-long tour of the country, which included meetings with Jordanian and international stakeholders to improve their understanding of key water issues in the region. They also visited a camp sheltering more than 80,000 refugees.

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Beyond the technical issues, the group learned that sometimes the problem with water is not science, but social science. For example, many Jordanian farmers choose to grow thirsty crops such as bananas and tomatoes and irrigate at levels that may not be sustainable. Water disputes in Jordan often originate from tribal claims that go back hundreds of years. Resolving these political challenges, so water can be used most efficiently, may quite literally save lives.

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Back in Nebraska, the students and staff shared their findings in a one-day conference in partnership with the Norman and Bernice Harris Center for Judaic Studies at UNL and the International Arid Lands Consortium. The conference was sponsored by the Forsythe Family Foundation in Human Rights and Humanitarian Affairs and the University of Nebraska-Lincoln program in Global Studies and Department of Political Science.

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Second Annual Student Research Forum

In May 2016, students and faculty working in multidisciplinary areas related to WFI's objectives were invited to present papers at a one-day student research forum. More than 10 different departments from all four University of Nebraska campuses were represented, with highly diverse expertise ranging from engineering and physical sciences to agricultural leadership and political science.

This was the second of an annual series designed to showcase the diversity of WFI's areas of focus, as well as demonstrate the institute's dedication to education and the students who will become the world's next water and food security experts and world collaborators.

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Nebraska Senator Roundtable on the Implications of Climate Change

In the spring of 2016, the Nebraska Legislature passed bill LR 455, which provided for a special committee to examine issues related to the impacts of climate change on the state of Nebraska. In response to LR 455, WFI Faculty Fellow Don Wilhite worked with Senator Ken Haar to organize a seminar for Nebraska senators on this important topic. The event was held on June 1, and included presentations by WFI, the National Drought Mitigation Center, the Nebraska State Climate Office and the High Plains Regional Climate Center.

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Communication

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Websites, Press and Social Media

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Last year, WFI continued raising the profile of the University of Nebraska and awareness of the institute by sharing news and information through news releases, social media and print publications. We began using a media monitoring service to provide insight and analytics on our reach in traditional news media and social media. To support our intensified communications efforts, websites for the Nebraska Water Center and the Water for Food Global Institute were reorganized to make it easier for visitors to find information, as well as to reinforce separate, but closely related, brands.

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The institute's social media presence includes regular posts on Facebook, Twitter and YouTube. Last year, the Institute added Instagram and LinkedIn to the mix, with key social media campaigns including coverage of the 2016 Water for Food Global Conference, World Water Day 2016, and the study tour to Jordan and subsequent Syrian conference.

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