WATER CURRENT

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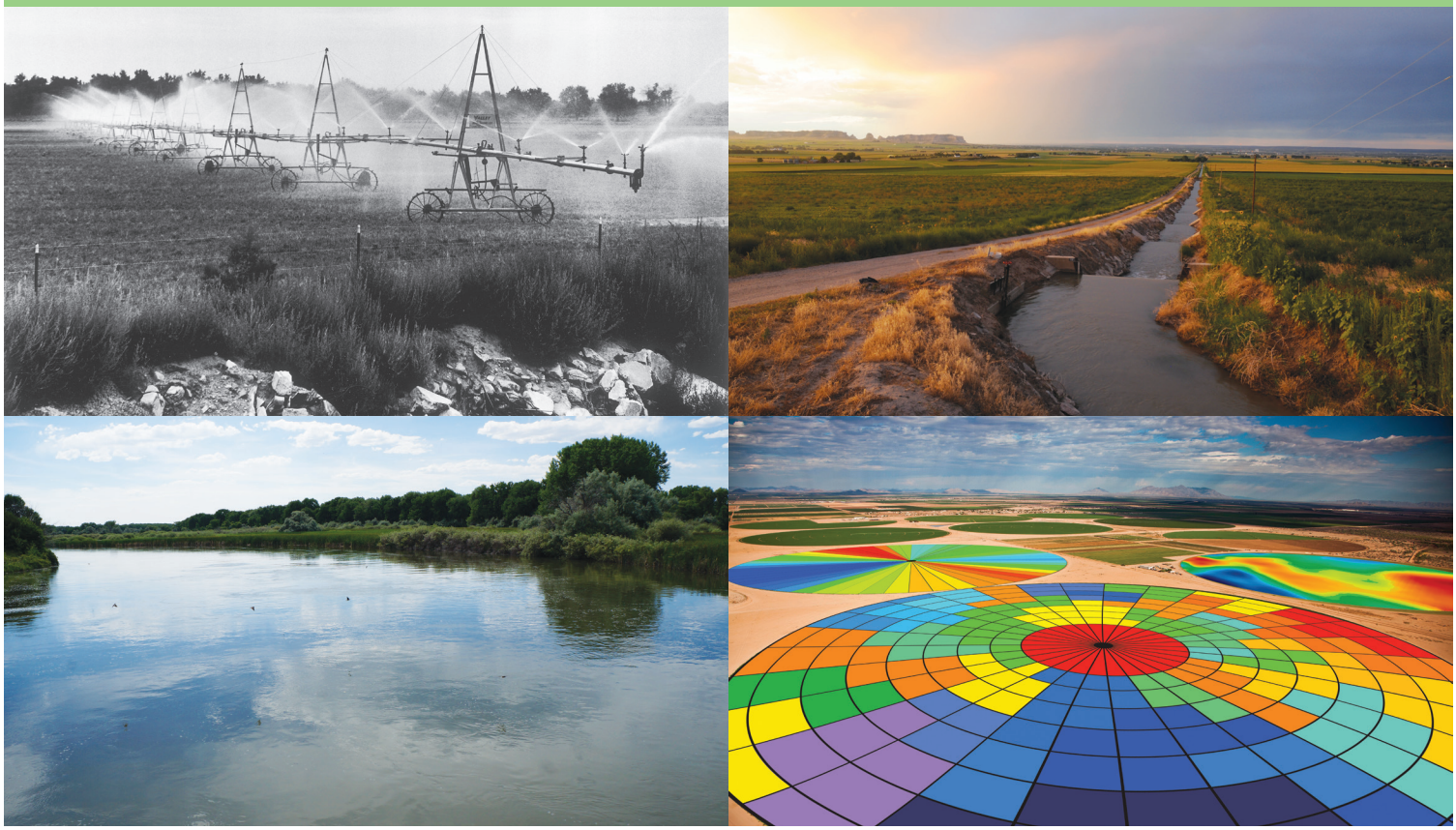
Reflections on Nebraska's Irrigation Legacy



Dear Reader,

We are enthused to bring you the second installment of our 50th anniversary edition of the Water Current. Five decades is a long time and as such we wanted to present a topic with commensurate history and impact. Since The Cornhusker State began experimenting with it as far back as the Civil War and today does it more than any other state, irrigation came to us more than we to it.

In keeping with the newsletter's 50th anniversary, these pages chronicle some of the key points, products and pioneers in Nebraska irrigation from the late 1960s onward. That history is complemented by a few articles on current resources and projects yielding new innovations in irrigation. This issue's highlights include:

- An informative look at the multiple uses of surface water across the state.
- Guest articles by Nebraska's four major center pivot manufacturers discussing their own histories.
- The low down on how we managed the huge increase in electricity demand from center pivots.
- Guest pieces about an online irrigation education platform and a multi-state research project to sustain the Ogallala Aquifer.
- And updates from the NWC on events, conferences and new staff.

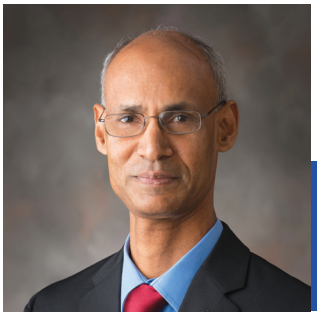
If water is the state's lifeblood, irrigation is its cardiovascular system. Maybe I should trademark that? Anyhow, it's a system with an impressive and interesting history and we hope you enjoy the samplings presented here.

Sincerely,

Jesse Starita

Jesse Starita
Editor, Nebraska Water Current

Nebraska Water Center
Daugherty Water *for* Food Global Institute



Water Management in a Season of Extremes

From the Director
Chittaranjan Ray, Ph.D., P.E.

As I write this, a commanding Nebraska summer storm is approaching our area with forecasters predicting much-needed rains over the next several days. It's a rite of summer to remind us just how much we miss water when it's scarce. I know many of you work on managing these hydrologic extremes every day of every season of every year. It is in that collective spirit that I write this update on our work to tackle some of Nebraska's pressing water issues through research, teaching, extension and outreach.

First, many of you reading this probably know by now that longtime NWC communications coordinator Steve Ress retired at the end of April. After twenty-one years serving the university, we wish Steve the best on his retirement and in spending more time on the farm and with his grandkids. His personal and professional contributions, particularly to this newsletter, will not be easy to replicate.

In that vein, several other staffing changes have developed in recent months, including: the appointment of Crystal Powers as research & extension communication specialist (please see her column in these pages); the addition of Rachael Herpel as assistant director of NWC; and the addition of Craig Eiting as web developer & graphic design specialist. Both Craig and Rachael will continue in their current capacities at the Daugherty Water for Food Global Institute (DWFI) while contributing 20% of their time each week to NWC. I'm also pleased to announce that Num Juntakut, a PhD student I co-advise, will graduate in August having completed his thesis on the occurrence, costs and management of nitrate in Nebraska groundwater. Finally, we welcome Indian post-doctoral fellow Jahangeer, who will be working on a Nebraska Environmental Trust-funded project on the transport of agrochemicals in the vadose zone. He will continue work done for the past two years by our previous post-doc Mohanasundaram Shanmugam, who returned to India this spring.

In June, more than 40 individuals joined our 47th annual Water and Natural Resources Tour. The tour, jointly organized by our center and Central Nebraska Public Power and Irrigation District, explored the North Platte River Basin from Pathfinder Dam in Wyoming to the shores of Lake McConaughy near Ogallala. Among the many highlights were stops at the University of Nebraska Lincoln's West Central Research and Extension Center, Wyoming's Fremont Canyon Powerplant and Oregon Trail landmark Chimney Rock. A gallery of tour photos is available on the Nebraska Water Center's Facebook page.

Earlier this year, we hosted our annual Spring Seminar Series on Nebraska's East Campus. Under the banner of "Advances in Irrigation Management," we invited four university researchers and private sector leaders from Lindsay, McCrometer and Reinke to present three emerging and established technologies to better manage agricultural water use. A video recording of each seminar is available on our website, under the conferences and events tab, if approved by presenter.

On the ground, we are increasingly engaging with partners in the Bazile Groundwater Management Area in northeast Nebraska. This area was formed by local producers, four Natural Resources Districts and the Nebraska Department of Environmental Quality to address high nitrate concentrations in area communities and domestic wells. Crystal has been attending steering committee meetings to collect information on what role we can and should play. In early July, DWFI executive director Peter McCornick, IANR senior associate vice chancellor Ron Yoder and I traveled to Norfolk to meet with project collaborators. Working alongside University of Nebraska–Lincoln faculty, we intend to submit project proposals to both NET and the Water Sustainability Fund.

Speaking of nitrates, I am pleased to announce that NET is also funding a new research project called "Novel approaches for controlling nitrate leaching and protecting Nebraska groundwater." The $85,000 grant will demonstrate how subsoil injection of recycled sawdust and wood shavings can establish a biologically active layer for interception and removal of dissolved nitrate after it has left the crop root zone. Follow-up activities will evaluate the best recycled wood sources, proper depth to intercept leaching nitrate and a two-year pilot study on three to four cooperator fields in Nebraska. Our own Dan Snow will lead the project, which will include contributions from University of Nebraska–Lincoln Biological Systems Engineering assistant professor Amy Schmidt, USDA research microbiologist Daniel Miller and myself.

Looking ahead, we are in the midst of finalizing our fall symposium, which we will host at Nebraska Innovation Campus Oct. 24 to Oct. 26. Rather than a strictly Nebraska affair, this year will be an integrated regional symposium for the Missouri River Basin states, including talks and perspectives from Montana, Wyoming, Colorado, the Dakotas, Kansas, Nebraska, Iowa and, naturally, Missouri. I am grateful for the funding and active participation of my fellow Water Resources Research Institute directors, the National Institutes for Water Resources, USDA, USGS, Epscor Nebraska, and DWFI. Mark your calendars and please check out the save the date flyer printed on page 16!

From vast river basins to tiny rain drops, the world of water quenches our lives and our work. Inside these pages, you will find stories about water, history, innovation and irrigation. I hope they may trigger a wellspring of thoughts and deeds as we all seek to manage water wisely in this season of extremes.

The Ebb and Flow

Crystal Powers

Research and Extension Communication Specialist, NWC

Hello! As the new Research and Extension Communication Specialist I am looking forward to joining this long history of wise water stewardship we have here in Nebraska. I have enjoyed beginning to get to know some of our current water leaders, and learning the history of our state's water use, policy, and research. My role is to be an open channel of communication between research and extension faculty throughout Nebraska's higher education system and water leaders throughout the state. My goal is that it be a two way path: what we can learn from each other and how we can best collaborate for larger impact.

I come from working as an Extension Engineer in the Department of Biological Systems Engineering at the University of Nebraska–Lincoln. There, I worked with faculty on improving air and water quality in livestock systems, primarily through extension programming, and also some teaching and research. I have a M.S. in Biological and Environmental Engineering from Cornell University and a B.S. in Biological Systems Engineering from the University of Nebraska–Lincoln. Along with my two young boys, Aiden and Liam, and husband William, I enjoy a small farm with dairy cows and chickens, north of Lincoln near Ceresco. I grew up a Husker on farms in rural Nuckolls & Thayer counties, where my uncle still farms.

In a whirlwind first couple months, I have enjoyed getting out to several of the Natural Resource Districts, including those leading the Bazile Groundwater Management Area, those in the Platte River Recovery Implementation Program, and the Niobrara Basin. A tour of the Central Nebraska Public Power and Irrigation District through our Water Tour of the North Platte Basin gave huge insights into the many uses of our surface waters. I have also enjoyed expanding my Extension connections by joining the Water Quantity and Quality Issue Teams and attending several of our faculty and student presentations. I plan to get out to the rest of the state in the next couple months. If you have events I should engage in, send them my way!

There are many excellent projects underway, and my hope is to be some of the grease on the wheels moving them along effectively. I also hope that we will lead the way on confronting the tough challenges to continuing to provide clean, abundant water for food, communities, energy, and fun!

I look forward to working with you!

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Central Nebraska Public Power and Irrigation District Fosters Preservation and Development of Surface Water

By Jeff Buettner, Public Relations Manager, CNPPID

It was 1934. America was in the midst of the "Great Depression." In the Plains' states, the effects of the depression were exacerbated by a withering drought. Farmers struggled to grow crops, stay on their land and feed their families during hard times. The rural areas and little towns in Nebraska that were dependent upon agriculture faced an uncertain future, trying to hold on until conditions improved.

Many years earlier, a man with a vision had foreseen the calamities that extended droughts could bring to Nebraska's farms and small towns. C.W. McConaughy, a grain merchant and the mayor of Holdrege, began a campaign in 1913 to bring life-giving irrigation water to south-central Nebraska, an effort in which he would be engaged for most of his remaining years. In a speech to the Omaha Chamber of Commerce in 1915, McConaughy said:

> *"When I have stood and seen for weeks great volumes of water rolling down the Platte in the flood season to become a nuisance in the lower Mississippi and when I have seen the semi-arid lands in our counties suffering and thirsting for water during the crop-growing season, my heart has been set on fire with a vision. I have a vision of what Nebraska can be and ought to be if a combined effort was made by all of its citizens to bring irrigation water to our region."*

McConaughy delivered that speech in the presence of Nebraska Governor John Morehead, himself an ardent supporter of developing and conserving the state's water resources. Morehead said at the same luncheon, "If we only had the intelligence to use the water the Lord has given us, we could produce crops in western Nebraska that would exceed the wildest dreams of the dreamer."

Over the next two decades, men like McConaughy, George P. Kingsley, George E. Johnson, Sen. George Norris and many others who knew that irrigated agriculture was the key to prosperity in western Nebraska continued to labor and advocate on behalf of irrigation. Other canals existed at the time, of course, but they lacked a crucial element: the ability to store water and make it last throughout the growing season.

Canals along the central stretch of the Platte River (a snowmelt-fed river) relied on natural flow, which was usually diminished or completely gone by the time the crops really needed it in July and August. At the time, only canals in Nebraska's Panhandle could rely on storage water, benefiting from the U.S. Bureau of Reclamation's Pathfinder Reservoir on the North Platte River in Wyoming.

The Central Nebraska Public Power and Irrigation District had been formed in 1933, but its future was in doubt. The project had met with strong opposition, its works had not been approved and funds were not available.

Subsequent developments would alter the course of the region's history. Before the decade had ended, the irrigation project, which included Kingsley Dam and Lake McConaughy, had been approved and construction was underway. It was designed to bring storage water to rich soil in south-central Nebraska that lacked only sufficient precipitation to make farming productive. Hydroelectric plants were included in the project to help meet Nebraska's growing demand for electricity and to help pay for the project.

The project accomplished all that its supporters said it would and more. Not only did it help develop one of the most successful and productive agricultural regions in the United States, the project's lakes and the canal which links them together proved a significant benefit to wildlife and created opportunities for water-based recreation where none previously existed.

Technological Advancements

Tracing the development of surface water irrigation takes one from lath boxes (crude, square wooden tubes buried in the bank of a farm lateral that allowed water to flow to the furrows) to sub-surface drip irrigation (SDI) tape. Irrigation equipment has advanced from siphon tubes and gated pipe to pivots controlled from a smart phone and telemetry equipment that allows real-time monitoring at the turn-out for irrigation applications.

Pivots are now the most common delivery system within many surface water projects, including Central's. Pivots require less water and labor than gated pipe, reduce percolation and runoff and can also reduce the need for soil tillage.

Another advancement in irrigation technology, although certainly not as widespread in Nebraska, is sub-surface drip irrigation (SDI). Typically utilized on high-value vegetables, orchards and nuts in other western states, Central conducted demonstration projects which confirmed that canal water could be utilized by SDI systems for row crops in Nebraska. Today there are many such installations on Central's canal system, most of which are located on pivot corners or fields that are difficult to irrigate with other methods.

As an added and long-recognized benefit, canals help recharge groundwater supplies in areas with surface water projects as water is conveyed to delivery points. While many parts of the state show declines in local water tables from measurements taken prior to the widespread development of groundwater irrigation, data from areas in which surface water projects are located indicate significant increases in groundwater levels.

Central was the first irrigation project in Nebraska to implement Supervisory Control and Data Acquisition (SCADA) in the early 1970s to control not only the main check gates on its Supply Canal and the main irrigation canals, but also its three hydroelectric plants. Today, more than 1,500 telemetering points on the irrigation system and in the hydroplants are monitored and controlled from a control center in Gothenburg.

In recent years, additional surface water irrigation projects in Nebraska have modernized their delivery systems, installing SCADA capabilities, automated gates, pipelines, and other improvements to enhance conveyance efficiency, conserve water and deliver more of the diverted water to the farmers' turnouts.

At Central, contracts for delivery service evolved from the original method that charged a flat rate for a volume of water – whether the crop needed the entire allotment or not – to a rate structure that provides a financial incentive to use only the amount of water needed by the crop.

In Nebraska, just as in other parts of the western United States, innovation by surface water providers, as well as the customers they serve, is becoming the norm as demands on the available water supply continue to increase.

Recreation

Perhaps it should come as no surprise that a perusal of newspapers from the 1920s through the early '40s – pre-reservoir construction days – revealed little mention of another benefit stemming from irrigation storage reservoirs that has grown in importance over the decades: recreation. After all, most Nebraskans had little experience with water-based recreation in those days, other than perhaps fishing in a farm pond, waterfowl hunting in the fall or winter. Or perhaps most people in that era had little time and/or money to spend on recreational pursuits.

Today, outdoor recreation is an industry in itself. Boats, campers, RVs, jet skis, canoes, kayaks, fishing and hunting gear and all manner of recreational equipment are as common as cornfields. For example, Keith County's economy relies more on recreation (at Lake McConaughy/Lake Ogallala) than any other economic sector, according to a recent study by the USDA Economic Research Service.

Other parts of the state benefit economically from the presence of irrigation storage, regulating and/or flood-control reservoirs as well, and can be considered state treasures for recreation and tourism. Among these are Calamus Reservoir on the Calamus River; Merritt on the Snake River; Sutherland, Maloney, Johnson, and Elwood in the Platte basin; Harlan County, Strunk, Enders, Butler and Swanson in the Republican watershed; Sherman in the Loup watershed; and Lewis & Clark on the Missouri River.

Cooperation with and among state and federal agencies, including the Nebraska Game and Parks Commission, the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation in developing these recreational assets has been critical to ensuring that Nebraskans and visitors from out of state have wonderful places to pursue water-based recreational activities.

Wildlife Habitat

In addition to the recreational and economic benefits associated with these reservoirs, they provide abundant habitat for fish and wildlife.

For instance, the presence of Central's hydropower-irrigation project has created an aquatic and terrestrial biological diversity not previously found in the region. This diversity provides for unique fishing, hunting, wildlife observation and photography opportunities, as well as providing habitat for a wide variety of fish and wildlife species.

Representatives from Central and other irrigation providers are members of the Governance Committee of the Platte River Recovery Implementation Program, a three-state/federal effort to preserve, protect and sustain wildlife habitat – particularly for threatened and endangered species – in the Platte River Basin.

But beyond federal programs, anecdotal accounts from lifelong residents of Nebraska tell of dozens of bald eagles and wild turkeys that congregate near Central's hydroelectric facilities, a sight unseen 50 years ago. The spectacle of the Sandhill cranes' spring migration is well-documented along the Platte River in central Nebraska, a stretch that benefits from an "environmental account" stored behind Kingsley Dam and managed by the U.S. Fish and Wildlife Service.

NGPC has designated Wildlife Management Areas associated with many lakes and reservoirs across the state, habitat that without the presence of the water would not exist.

Stemming largely from a need and desire to bring irrigation water to Nebraska's often parched croplands, many other benefits have been bestowed upon the state. By providing irrigation, hydroelectric generation, power plant cooling water, groundwater recharge, recreation and wildlife habitat, Nebraska's canals and reservoirs are tremendous assets to the state and valuable tools for use in conserving and protecting the state's water and natural resources.

A Historical Look at Nebraska Water Availability and Use

Find this story online at **watercenter.unl.edu.**

Biological Systems Engineering, University of Nebraska–Lincoln

Test pumping, date unknown, perhaps 1940s

Lindsay Corporation Aims to Help Growers Make the Most of Every Drop of Water

By Lindsay Corporation

For more than 50 years, Lindsay Corporation has been at the forefront of research and development of products and services designed to meet the world's rapidly growing demand for food, fuel and fiber.

A global company, Lindsay is rooted in the Midwest and remains committed to the entrepreneurial legacy of its founder, Paul Zimmerer. Along with his two sons, Zimmerer designed and built the first Zimmatic® center pivot – which began operating in 1969 on a farm near Newman Grove, Nebraska. That first system is still operating today.

Shortly after that first pivot went to work, Lindsay engineers designed and patented two important design features – the external collector ring and the Uni-Knuckle joint. The external collector ring ensures continuous electrical power for each tower drive while reducing operating costs. The Uni-Knuckle Joint is a span connector that provides Zimmatic systems with the flexibility to handle slopes of up to 30 percent with little or no structural stress.

"These were early, but very important advancements for center pivot irrigation," said Randy Wood, president of Agricultural Irrigation for Lindsay Corporation. "These features are still incorporated into every Zimmatic system."

Advances in computerized irrigation began taking shape in the 1990s. Lindsay was first to market with technology that allowed off-site monitoring and system control. The Automated Irrigation Management System (AIMS) control panels gave growers greater programming control and paved the way for computer-based pivot telemetry, another key innovation area for Lindsay.

Lindsay continued to lead the way in technological innovations over the next decade, introducing its award-winning FieldNET® technology in 2006. A fully integrated, wireless management tool, FieldNET gives growers the ability to monitor and control their irrigation systems from virtually anywhere via a smartphone, tablet or computer.

"FieldNET was, and continues to be, a game-changer for irrigators," Wood said. "Since it's launch, we have continuously enhanced the technology's features and extended its capabilities to more growers around the world. It is now compatible with almost any brand of electric pivot - delivering real time information, so growers can see exactly what their pivots are doing and control them quickly and easily."

In 2017, Lindsay took remote irrigation management to the next level with the launch of FieldNET Advisor™ – the industry's first technology that helps growers decide precisely when, where and how much to irrigate. With FieldNET Advisor, growers receive continuously updated, science-based recommendations that are customized for each field – saving time, money, water and other inputs.

FieldNET Advisor currently covers 21 crops and, by the end of this year, its capabilities will be extended beyond the U.S. and Canada to growers in 17 additional countries.

"This type of cutting-edge technology, along with other precision irrigation solutions, will play an important role in meeting global food challenges," Wood said. "From design to installation to operation, we are committed to providing growers around the world with unique, turnkey solutions that maximize time and labor while making the most of every drop of water."

An early 1980s Lindsay dealer advertising their popular Zimmatic pivot.

Five Decades After Founding, Reinke Manufacturing Continues to Innovate

By John Davis, V.P. of Engineering, Reinke Mfg. Co, retired

Reinke Mfg. was one of the pioneers of center pivot irrigation. The founder, Richard Reinke, had seen the early attempts to bring this new technology to farmers and was convinced there was a better way. His approach was innovative, but still grounded in experience and common sense. Like many new industries, success was going to be dependent on the creativity and the resolve of a good leader. Mr. Reinke was that person. He had a knack for finding and getting the most out of talented people and he had the courage to move forward when others may have given up. Reinke Mfg. continues to be privately held by the Reinke family and still maintains those same qualities.

Two important innovations were introduced with the new Reinke Electrogator Pivot. First was the all electric drive system. This allowed the system to move without watering, and provided a more accurate speed control – thus improving water application efficiencies. The second was the "V-Jack" truss system now used by all major pivot manufacturers. This truss design brought added stability and made longer spans possible. Longer spans meant fewer tracks in the field and were more cost effective.

These two innovations have now become the standard being used by all the major manufacturers.

As time went on Reinke focused on a more efficient design. High strength materials were incorporated into the design reducing the "dead weight" of the structure. Lighter weight would help reduce rutting and reduce the stress on driveline components.

In 1974 the first aluminum system, the Alumigator, was introduced. This model provided the light weight and corrosion resistance of an all aluminum structure and water conduit.

As the industry matured it became evident that producers wished to pick up the acres in the corners that were missed with a center pivot. Thus the Swing Arm Corner and the Lateral system became part of the product line in 1980. The Reinke Swing Arm had the longest span in the industry.

Incredible growth of pivot irrigation proceeded domestically. Reinke entered the international market in early '80s, at first moving into markets in the Mideast, and today is all around the world with manufacturing facilities in Nebraska, Kansas and Beijing, China. Equipment warehouses or offices for the international market are located in South Africa, Argentina, Russia, Mexico and Australia.

During the '80s and '90s more pipe diameters and materials were added to accommodate the growing and varied applications of this irrigation technology.

Growers' needs continued to evolve and new innovations began to move from structural/mechanical to the application of emerging electronic technology. In 2002, Reinke introduced the use of GPS for guiding corner systems and followed that with and End of System GPS control to improve the accuracy of end guns.

A solid state replacement for the old mechanical timers, used to control the speed of the system, greatly improved the accuracy of water application amounts. Also, a touch screen interface control was made available in 2010.

Incorporating new technology into the control system allowed utilization of the explosion of electronic technology. For example, remote control and monitoring via cell phone systems provides added efficiency in the grower's management of his irrigation operation.

Center Pivot Irrigation has had a tremendous impact on agriculture. It has improved the way of irrigating previously irrigated land. However, its greater impact has been making it possible (practical) to irrigate and bring into productivity a vast amount of new land. Thanks to the creativity and resolve of Mr. Reinke and his contemporaries, this is providing income for growers, and more food for an ever-growing world population.

Reinke's original Electrogator pivot was first built in 1968

A modern GPS-equipped Reinke pivot irrigates a canola field near Spokane, WA.

T-L Irrigation: A Pioneer in Center Pivot Irrigation

By Tharran Gaines, Guest Contributor

LIKE NO OTHER

It's been more than 40 years since T-L Irrigation introduced its first center pivot irrigation system. But those four decades are only a blink of an eye in terms of irrigation history. Fact is, the use of irrigation can be traced back more than 6,000 years ago to when farmers in Egypt and Mesopotamia (present day Iraq and Iran) began using flood waters from the Nile and Tigris/Euphrates Rivers to water their crops. It wasn't until 1952 that the idea of a center pivot sprinkler system was even conceived. According to the American Society of Agricultural and Biological Engineers (ASABE), Frank Zybach patented the first "self-propelled sprinkling irrigation apparatus" on July 22, 1952.

Two years later, Robert Daugherty, the founder of Valley Manufacturing in Valley, Nebraska, acquired the patent and developed a commercial product that debuted in 1954. Valley had the market for center pivot systems pretty much to itself through much of the 1950s and '60s, until the patent expired in 1969. Despite the advantages a center pivot system offered, it was still slow going for the center pivot industry as a whole through much of that time. In fact, only seven center pivot machines were built in 1955. By 1960, production was still limited to about 50 units a year.

By the end of the 1960s, however, the market took off – just as the original patent protecting Zybach's invention ran out. One reason for the sudden growth was that more and more farmers were facing labor shortages as young people were leaving the farm. Wessels Living History Farm records that one man using a gated-pipe system could irrigate approximately 320 to 480 acres per day. "However, if that same farmer could buy and install several pivot systems, he could supervise the irrigation of 1,200 to 2,000 acres per day."

Secondly, center pivot irrigation units allowed even hilly land to be irrigated. Farmers who were looking to expand in the 1960s were finding that all of the flat land that could be irrigated by gravity was already priced out of the reach of the average farmer. However, there was still plenty of fertile, but hilly, land in Nebraska that could be purchased at a reasonable price.

Finally, irrigation provided an insurance policy against drought, which often plagued the Great Plains. With irrigation, farmers … and their bankers … could count on a crop, no matter the weather. It also allowed farmers in many areas to grow more valuable crops, such as corn, where only wheat or grain sorghum had previously survived. By 1972, there were 2,725 pivot systems in Nebraska alone. Thirty years later, an estimated 258,000 center pivots were installed around the world. "Even before the patent ran out in 1969, other companies were bringing out their own systems with their own unique differences designed to avoid patent infringement," according to Wessels.

Early on, LeRoy Thom, a farm-raised agricultural engineer from Minden, Nebraska, and later on his sons, Dave and Jim, decided they, too, could improve on center pivot machines on the market. Founded in 1955 by Leroy Thom and partner J. G. Love, T-L Irrigation had already become established as a manufacturer of gravity irrigation systems and grain dryers. In 1969, seeing an opportunity to change the market, the Thom family developed and introduced a system that used hydraulic motors to drive the wheels on each tower. The idea was that hydraulic motors would allow the systems to move around the field at a constant rate, rather than starting and stopping at set intervals as electric motors do, thereby applying water more evenly.

"We looked at electricity," LeRoy admits. "But we had some reasons why we decided against powering them with electricity. First of all, farmers work with hydraulics every day and understand them," he adds. "They usually can make what repairs are needed themselves." Unfortunately, the 1980s took a toll on the industry as the export market for American grain literally dried up. Agricultural credit became extremely tight, farm machinery companies went out of business or merged, farmers were in danger of losing their farms and the majority of center pivot companies went out of business.

Today, T-L Irrigation, along with three competitors in Nebraska and a company in Oregon that only builds custom-ordered pivots, are the only that remain in business in the United States; and T-L is still the only center pivot manufacturer that uses hydraulic drive. Yet, there were certainly plenty of attempts in the late '60s and early '70s to enter the rapidly growing center pivot market. According to Wessels Living History Farm records, "Over the years, there have been over 80 individuals or companies who have tried to make and sell center pivot systems, even though some of the smaller companies were bought by the giants."

Fortunately, those that have remained in business continue to develop new technology that allows farmers to be even more efficient. For example, T-L not only offers linear and towable units, in addition to circle and corner pivot irrigation systems, but remote control that allows the operator to start, stop and monitor the system from an office computer or cell phone. Pivot sprinkler systems can also be configured to nearly any shape and size a producer wants to cover. Needless to say, the industry has come a long way since Frank Zybach had an idea for an overhead pivot sprinkler system that simply pivoted in a circle.

A Brief History of Center Pivot Developments by Valmont Industries

By Rich Berkland, V.P. of International Sales, Valmont Industries, retired

The story of humankind is linked to the story of agriculture; without the ability to grow enough food and fabric, civilization cannot sustain itself. One of the most important factors in cultivating crops is, of course, ensuring they receive enough water. The amount and timing of rainfall is too often inadequate to meet growers' needs, giving rise to the need for irrigation.

Even though practiced for over 6,000 years, irrigation technology changed very little until the 20th century, with the advent of powered turbine pumps and then mechanized irrigation. These irrigation machines were called center pivots, first developed and manufactured in Nebraska in the 1950s. The less-efficient, labor-intensive method of flood irrigation is still used in the majority of irrigated fields around the world, but is rapidly being replaced by precise, data-driven options that can be controlled from any smart device, even from thousands of miles away.

Valmont Industries (called Valley Manufacturing prior to 1968) has played a major role in the introduction and evolution of center pivot technology, and continues to lead the industry with a worldwide footprint of manufacturing and service facilities.

Time may be linear, but the history of irrigation culminates in the iconic circles formed by utilizing center pivots.

Valmont Center Pivot Timeline

1947 Frank Zybach constructs the first water-powered center pivot prototype in Colorado.

1952 Zybach obtains a patent for his center pivot invention, which is powered by water pressure.

1953 Frank Zybach moves to Columbus, Nebraska, and partners with his brother-in-law, A.E. Trowbridge, to produce center pivots.

1954 Robert Daugherty, owner of Valley Manufacturing (now Valmont® Industries), obtains an exclusive license from Zybach and Trowbridge and begins manufacturing center pivots.

1955 Valley Manufacturing sells their first center pivot to Edward Nelson of Clarksdale, Mississippi.

1955 A.E. Robinson of Kansas City, Missouri, becomes the first commercial dealer selling center pivots.

1966 Valley pioneers the use of galvanized pipe and structural components.

1967 Valley makes the first international sale to a customer in France.

1968 The original Valley patent protection expires and several other companies enter the market utilizing the center pivot concept.

1974 Valley Irrigation introduces the Corner machine, initially with cam guidance, selling 10 machines in the first year of production.

1974 Valley introduces below-ground guidance for their corner machine and obtains a patent.

1976 Valley introduces the first linear machine at the Cortopassi Farm in Lodi, California.

1983 Valley introduces the first remote control of center pivots via radio communication. This innovation is called the Valmonitor.

1990 Valley introduces the first computerized control panel.

1992 Valley introduces polyethylene-lined pipe for corrosive water conditions.

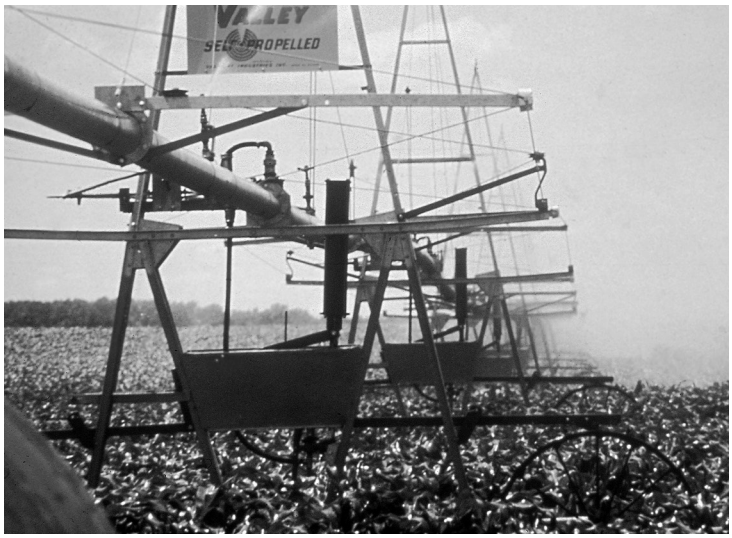
2003 Valley introduces monitoring and control by hand-held devices.

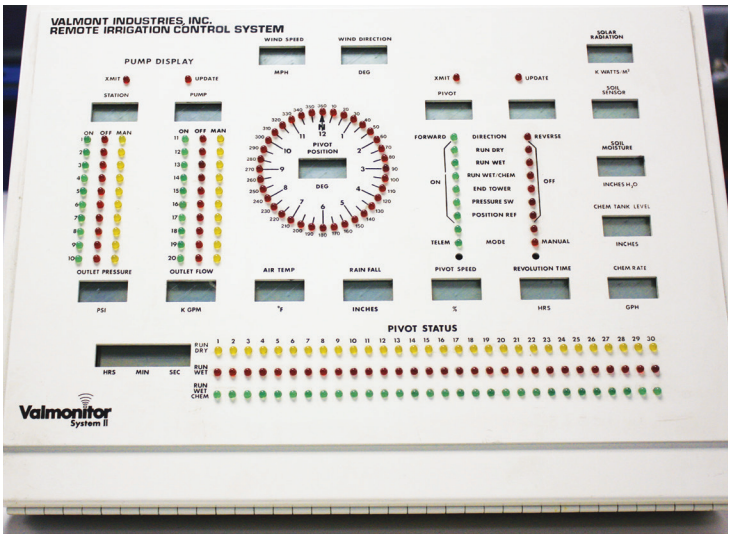
2010 Valley pioneers Variable Rate Irrigation.

2012 Per the USDA, 50% of irrigated land in the USA is now irrigated with center pivots.

2017 Valley releases the X-Tec® center drive, offering variable speed and half the rotation time of conventional motors. This innovation complements Variable Rate Irrigation and the application of chemicals with center pivots.

Valley Through the Years





University Research Key to Lightening the Load of Nebraska Irrigation

By Jesse Starita, Education & Outreach Coordinator, Daugherty Water for Food Global Institute


LaVerne Stetson

There's two things you should know about LaVerne Stetson: he solves problems and does not waste time doing so. For example, after graduating with his B.S. degree on a Saturday, he took one day off before beginning work the following Monday.

"I was glad to get a job with pay," he says, grinning.

That was 1962. The fountainhead of a five-decade stint with USDA's Agricultural Research Service and University of Nebraska–Lincoln's Department of Biological Systems Engineering. Stetson initially worked with 45 agricultural engineers nationwide on anything involving rural electrification. An early project sought to use microwave energy to electrocute insects in grain bins without damaging the grain. Eventually, the state's rapid growth in electric-powered center pivots and large-scale power generation stations led Stetson to his most consequential work.

As more pivots circled the Nebraska landscape, they drove a commensurate increase in energy demand. This forced wholesale power distributors, such as NPPD, to charge individual public power districts at higher rates. These rates, known as peak demand or peak load, are applied when electrical power is expected to be provided for a sustained period at a significantly higher than normal supply level. To recoup the cost increases, power districts were charging irrigators twice: once for their actual energy consumption and another for offsetting the supply costs of peak demand.

"Some power districts we're actually saying we're not hooking up any more irrigation electricity because of the peak power demands."

This led Stetson and his research partner, Darrell Watts, to set up a pilot project to see if irrigation could be periodically shut down to manage peak load.

"We had a discussion with the folks at Custer Public Power about peak demands and someone gave the idea of controlling them under peak demands. We thought at the time that we know there's over-irrigation and if you control a portion, you'll make them better irrigators and if you control them during your peak demand, you'll save them costs and you (the district) costs."

So in 1972, Stetson and Watts recruited 15 center pivot irrigators within Custer Public Power's service area. Their central question was *can we shut them off*? The irrigators rotated through a load control schedule, meaning each was shut off for a fixed amount of time. To shared excitement, Stetson, Watts and their graduate students gathered soil moisture and energy demand read outs. The moisture was fine and they'd shaved "a little bit of peak off at a local substation." It was a small first step, but it slowly induced a culture shock around the state.

"It scaled by word of mouth," Stetson recalls.

"Statewide, the managers had meetings and the guys talk. You know they'd say 'this is what we did and this is what we saved and this is what our irrigators saved.' Guys said 'Oh boy, I don't think our irrigators would do that, but we'll try it.'"

For the first five or six years, change occurred slowly. But as more farmers converted from gravity to pivot irrigation, it meant more horsepower in need of management to avoid the peak loads that were a hardship for all.

"So that's where you could make an impact," Stetson says, referring to large capacity pumps. "You knock off 100 horsepower and you've done something. If you're in the Platte Valley, you've got to control 10 people to get to 100 horsepower."

Over the years, advances in monitoring electrical demand and load made for easier controls. Power districts acquired computers and software to monitor substation loads. Irrigation technology advanced so turning pivots off and on could be done remotely with a thumb swipe. And the Rural Radio Network got involved by broadcasting to irrigators the time and day of their shutdown. For the most part, the irrigation load control system that Stetson and Watts pioneered in the 1970s is still the statewide model today.

Along the way, Stetson says this has saved multi-millions of dollars, while allowing for the expansion of irrigation. Since the electrical load is better managed, it's meant NPPD has delayed the need for additional costly power plants. Meanwhile, power districts could add more pivots to the grid while ensuring their costs were covered. Further downstream, irrigators benefited from a fairer rate – one that didn't charge them twice.

Stetson never bothered to tabulate the cumulative savings. Why would he when he's always been more interested in solving problems?

"I don't think we ever wrote it down," he says, referring to his early days working with public power districts.

"It was 'Well that's good, but let's do some more next year.'"

Irrigation Education

By Kylie Blythe, Content Strategist

irrigation.education

Remote monitoring systems are found in many places – cars, home security, robots, and more. In agriculture, telemetry allows farmers to access and control their center pivots and other farm equipment using a smart phone or computer. With the accessibility and ease of remote monitoring, it is quickly becoming a popular technology tool on farms.

Telemetry products communicate directly between the hardware (what's out in the field) and the software (what's on your desk or in your hand). There is a large variety of communication options, including cell towers, data radios, and WiFi, that allow farmers to tailor their control technology to whatever signal best fits their location and needs.

Advanced features, such as Variable Rate Irrigation (VRI), can be utilized when farmers want to control the amount of water applied to certain areas of their fields. Telemetry can even be set up to send notifications when equipment starts, stops, or experiences a shutdown. Knowing the status of their farm equipment allows farmers to control and monitor their operation from anywhere at any time for efficient irrigation management.

Another important aspect of irrigation management is knowing what irrigation methods are the best fit for an operation. Farmers are turning to irrigation.education for free information on irrigation and irrigation products. It is vital to fully understand all the factors involved in a farming operation before purchasing any irrigation equipment. irrigation.education is a great source for best practices and product advice for most applications.

For example, by learning more about the different soil types in a field, farmers can adjust irrigation practices to reduce runoff, increase efficiency, and maximize yields. From sprinklers, to boombacks, to center pivots and components, and even crop-type training, anyone can find information on products they are interested in on irrigation.education. Make the best irrigation decision for your operation by learning more at irrigation.education today.

Collaboration Key to Success for Ogallala Water Coordinated Agriculture Project (OWCAP)

By Amy Kremen, Project Manager, Ogallala Water Coordinated Agriculture Project

OgallalaWater.org

The OWCAP team consists of approximately 80 people—including faculty, students and post-docs—based at nine institutions in six of the eight Ogallala states. The team of economists, agronomists, sociologists, climate scientists, and engineers are coordinating with irrigators, groundwater management districts, state government representatives and other key stakeholders to identify practices and institutional changes that can prolong the life of the aquifer and improve the sustainability of agricultural systems and rural economies in the region. The project is supported by USDA-NIFA from 2016-2010.

The team is led by Colorado State University's Meagan Schipanski (Assistant Professor, Soil and Crop Sciences and mentor to CSU PhD student Agustín Núñez). Chittaranjan Ray (Professor and Director of the Nebraska Water Center) serves on OWCAP's leadership team and mentors two post-docs, Erin Haacker and Vaishali Sharda. Other University of Nebraska–Lincoln team members are Karina Schoengold (Associate Professor, Agricultural Economics and mentor to CSU post-doc Mani Rouhi Rad), Tim Shaver (Associate Professor, Agronomy and Horticulture), Daran Rudnick (Assistant Professor, Biological Systems Engineering and mentor to Nebraska PhD student Himmy Lo). More about the team at http://ogallalawater.org/people/?group=faculty-postdocs-students-staff.

OWCAP collaborators have published articles (technical as well as for lay audiences) on wide range of topics related to water use and management, including deficit irrigation, soil health, soil water sensor calibration, climate trends, groundwater modeling and more. The Ogallala Aquifer issue of Colorado Water (Nov/Dec 2017) provides a detailed overview of the project's goals and activities. Additional information about the project (events, announcements, research results and more) can be found at the project's website (www.ogallalawater.org) and via social media (Twitter: @Ogallala_water; Facebook: @Ogallalawater.org).

Platte River Basin Ecosystem Symposium Returns

By Crystal Powers, Research and Extension Communication Specialist, NWC

In early June, the Crane Trust and Nebraska Water Center hosted the 13th Platte River Basin Ecosystem Symposium to a group of researchers and interested Nebraskans at the beautiful Crane Trust Nature and Visitor Center near Wood River.

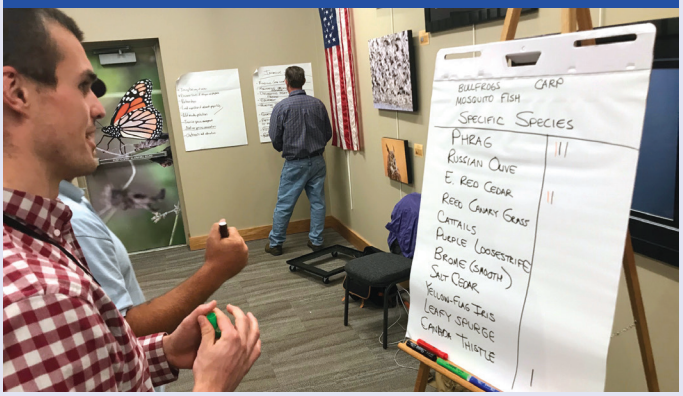
The symposium was reestablished as part of the Crane Trust's 40th Anniversary celebration. The Crane Trust and the Water Center have been long-time partners to further research and engagement around the Central Platte flyway. Much of this research focused on improving outcomes for wildlife of the region including the endangered whooping crane, piping plover, and interior least tern. This involved researching impacts of changes in habitat and water flows. Many of these efforts come through the Platte River Recovery Implementation Program – an interstate effort to increase stream flows as well as enhance, restore and protect habitat via adaptive management. Many successes and adaptations where shared, with good progress being made on habitat improvements and modest streamflow increases.

George Archibald, founder of the International Crane Foundation, provided a keynote highlighting the issues facing Mongolia and how they are very similar to those found in the Great Plains. The day was capped by a moving tribute from Mike Farrell of the Platte Basin Timelapse Project: "My Path to the River."

The focus of the second day was strategizing next steps for key issues facing the Basin. Invasive species, particularly Phragmites and Red Cedar, were identified as one of the key challenges. Researching more efficient methods of control is critical to reduce the extensive investments of money and labor. Another priority issue identified was restoring larger and better connected areas of native habitat to benefit key species. The group would like to bring these issues together in the Basin-wide strategic plan.

Symposium presentations will be available soon on our website.

The Platte River Basin Ecosystem Symposium featured both presentations and interactive sessions during its reestablishment June 5th-6th at the Crane Trust Nature & Visitor center near Wood River, NE.



Symposium photos courtesy of Andy Caven.

Longtime NWC Communications Coordinator Steve Ress retired on April 27. Ress's contributions were recognized at a retirement party in which he was presented with a framed photo of his beloved Cornhuskers taking the field at Memorial Stadium. Thank you Steve!

2018 Nebraska Water and Natural Resources Tour

The action-packed Nebraska Water and Natural Resources Tour, held June 26th-29th along the North Platte River Basin, included stops at natural and man-made monuments, including Wyoming's Pathfinder Dam and Seminoe Reservoir and Nebraska's Chimney Rock and Lake McConaughy.

Photos courtesy of Jesse Starita.

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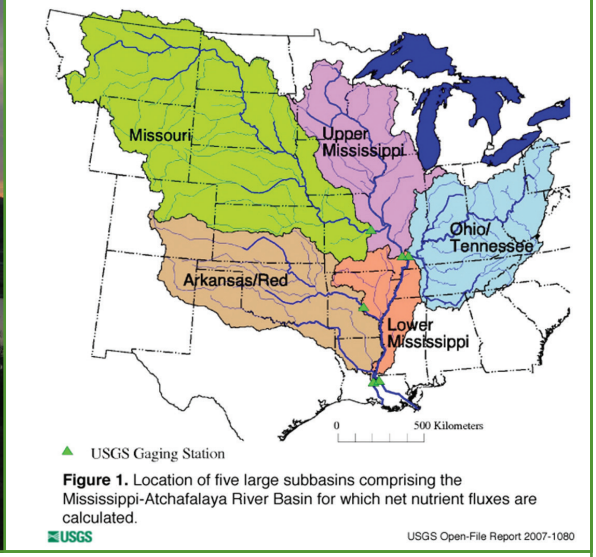

Figure 1. Location of five large subbasins comprising the Mississippi-Atchafalaya River Basin for which net nutrient fluxes are calculated.

Nebraska Water Center
Daugherty Water *for* Food Global Institute

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