Early Rangeland Partners: Water and Wind

Windmill Pioneering in the American West.

By Christopher K. Wood, Tyler W. Wood, and M. Karl Wood

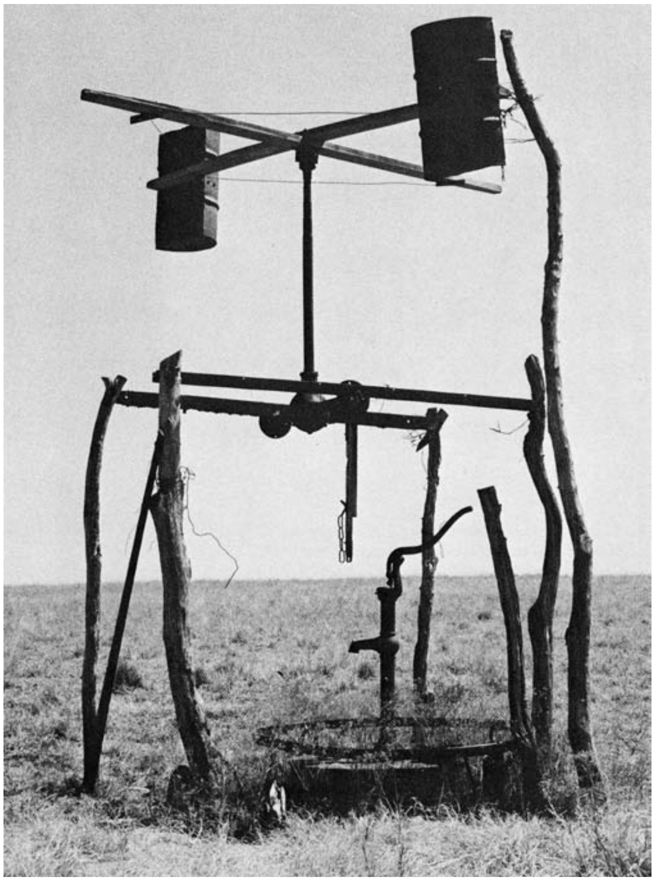
The western United States was explored by conquistadors, fur trappers, and soldiers, but settlement came from pioneers in mining, farming, and ranching using tools such as barbed wire and windmills. Windmills had been used in many parts of the world, especially Europe, for centuries. Designs of these large European windmills were adapted to the New World. A slow-moving cumbersome mill was erected near Jamestown, Virginia, in 1621 followed by hundreds of others throughout the English, French, Danish, Swedish, German, Portuguese, and Spanish settlements. Most of these mills were used to grind grain into meal or flour and were not adequate for pumping water to fill a trough or for operating machinery on a small scale.

A writer in *Scientific American* in 1860 expressed the need for water when he declared, "The great want of Texas is sufficient water… . There is a million dollars lying waiting for the 1st man who will bring us … a windmill, strong, durable and controllable." Settlement was limited to perennial streams with vast areas in between that were arable and grazable if only potable and stock water could be found. Indeed, much of the desert areas of the West had grazable forage, but grazing by wild ungulates such as bison and, later, domestic animals was often limited because of the lack of drinking water. The solution was developed by a rural mechanic in distant New England. Without improved windmills (products of the industrial revolution), occupancy of the plains, prairies, and deserts of the West might very well have been delayed for many decades.

Invention of Mills for the West

Daniel Halladay was the New England mechanic who invented the 1st commercially successful self-governing American windmill. Inventors throughout the country were attempting to find ways to harness the wind for pumping water or mechanical power, as steam, animal, and human power were considered too expensive. In Ellington, Connecticut, Halladay and his associate John Burnham saw the need for a mill that without human attention would automatically turn to face the wind and govern its own speed to prevent its destruction by centrifugal force. Within a short time, in 1854 Halladay had invented a windmill with a rigid vane that always kept the wheel facing the wind similar to a weather vane on the top of a barn. In light winds, the blades faced the wind at angles from which it derived the greatest power, but as the wind velocities increased and the wheel spun faster, a centrifugal governor changed the pitch of the blades so that they presented less of their surface to the wind and thus controlled their speed. An operator could also turn the blades into a position parallel with the vane and wind so that the wheel ceased turning. The mill was successfully tested for 6 months by pumping water from a 28-foot-deep well and forcing it a distance of 100 feet into a reservoir in the loft of a barn.

The widely promoted new mill was demonstrated at the New York State Fair and featured in *Scientific American,* but sales in the region never achieved the volume that its makers desired. The makers saw a much greater market in the Midwest, so they moved near Chicago to Batavia, Illinois, in



An example of a homemade windmill constructed in the 1st half of the 20th century. Photo from A Field Guide to American Windmills by T. Lindsay Baker.

1856. Railroads quickly became important customers for the company as they built across the plains and prairies into the West and needed water for boiler supplies.

The windmill was modified in 1868. The early mills only had 6 or 8 blades and ranged in size from 6 to 16 feet in diameter. The smaller mills had solid wooden blades, while the larger mills had iron frames covered with sailcloth. The newer models featured thin wooden blades nailed to wooden rims and mounted on hinged castings at the ends of wooden arms and became known as "sectional wheels." A vaneless windmill would blow around to the lee side of the tower and would turn behind the tower instead of in front of it. Vaneless mills were predominant among the sectional-wheel-type mills during the 1870s and 1880s.

A solid wheel pattern that did not fold in any direction was invented in 1866 by the Reverend Leonard H. Wheeler, a missionary among the Ojibway Indians in Wisconsin. These mills adjust their angle to the wind to control their speed and thus prevent their destruction from centrifugal force. This idea remains the most common form of governing used in windmills today. It was called the Eclipse, which became one of the most common windmills used in the 19th and early 20th centuries. By the 1880s, it was made in sizes from 8½–30 feet in diameter. The Wheeler's company eventually became the Fairbanks, Morse and Company in the 1890s. Like the Halladay mills, the Eclipse catered to the railroad industry.

Early Windmill Manufacture

Many makers followed and modified the pattern of the Eclipse. A few horizontal windmills were invented with a wheel that spun on a vertical shaft. Competition among windmill manufacturers from the 1850s through the 1870s was keen and at times even cutthroat. Claims of patent infringement were common.

Many farmers and ranchers chose to build their own windmills, and these windmills came into use by the 1870s on the plains and prairies. They were quite common in the central Great Plains by the 1890s. Homemade mills very often were erected by the most firmly established and affluent farmers and ranchers rather than individuals who simply could not afford to buy factory-made mills. Despite this fact, the greatest virtue of the comparatively inefficient homemade mills was their low cost. They were built with the builders' spare time and scrap materials on the farm. Total expenses seldom exceeded $4 or $5 and often cost nothing. Scrap materials included old lumber, lath, shingles, split rails, old packing boxes, barrel staves, coffee sacks, and the tin from old tin roofs plus cast-off farm machine parts with bearings and grease cups.

A common homemade mill was the Jumbo, also known as the Go-Devil or Ground Tumbler. This mill was similar to a water mill with a horizontal axle that depended on wind to overshoot the top. Most were not self-governing to adjust for wind direction and speed. Another quite common homemade mill was the Battle Ax. It was found throughout the plains, especially in the Platte River valley. It consisted of a horizontal axis with fan-shaped blades on a wooden tower. Other homemade windmills had horizontal mills with vertical axes. One horizontal mill near Lincoln, Nebraska, had a diameter of 40 feet with blades that were 12–14 feet high. A few miniature Old World mills were also built. Homemade windmills could not compete with the factory-made mills in efficiency, but with enough wind, the lower costs compensated for less efficient homemade windmills.

By the 1870s, windmills were being made exclusively from iron and steel. By 1890, steel had become sufficiently inexpensive to allow increasing numbers of competitively priced windmills. However, the number of wooden mills actually increased in the years before World War I, but the number of steel mills manufactured grew faster than the increase in wooden mill production. By 1914, wooden mills comprised 23% of all windmills. Steel mills were self-oiling but had a reputation for being weak and difficult to repair compared to wooden mills, which could be repaired with nails, wire, and rawhide. Wooden windmills remained on the market until at least 1940. In time, the economy and efficiency of steel windmills prevailed and became the windmill of choice.

A windmill with circular blades in east Custer County, Nebraska, in 1888. Photo courtesy of Nebraska Historical Society.

Windmill Designs

Many different designs were applied to windmills, especially the blades, with each manufacturer proclaiming its design to be the best. Thomas O. Perry, an engineer, conducted experiments in 1882 and 1883 for the U.S. Wind Engine and Pump Company to ascertain the design for the most efficient windmill wheel. In over a year's time, he tested more than 50 different windmill designs in more than 5,000 experiments. By the end of the trials, the engineer had developed a completely new wind wheel that was 87% more efficient than the wooden wheels used on most mills of the day. The new design consisted of concave sheet steel blades set on a specific angle to the wind and fastened to steel rims and arms that presented the least possible wind resistance while still retaining sufficient strength. His company rejected his new redesign because of all the changes that would have to take place in manufacturing the new product. In 1888, Perry joined up with another inventor named LaVerne Noyes to organize a company to manufacture Perry's scientifically designed windmill. Noyes thought of the name Aermotor, which today is known throughout the world.

The windmill devised by Thomas Perry and placed on the market by LaVerne Noyes became the basic pattern for many later mills. Its wheel was made from concave sheet steel blades mounted on steel rims and arms and is known today as the Perry wheel. Because it rotated so fast, a back gear was used, allowing 3 revolutions per stroke of the pump. This gearing gave the mill great leverage, allowing it to turn in a light wind of about 4 miles per hour. The back-gearing also gave the pump a long, easy stroke instead of the short, quick, and jerky strokes of the direct-stroke mills.

A major problem of steel windmills was corrosion. Mills were painted until about 1890, when galvanizing with zinc alloy became standard. The last major development in the windmill came in 1915. A housing that needed to be filled with oil only once a year was built around the mill's gears. This relieved the range rider of his biweekly greasing chores and somewhat diminished the windmiller's job. Because of the dependability of this improved windmill, worries over water shortages were eased for the rancher, farmer, and rural dweller.

Aermotor became the largest of the American windmill manufacturers. Only 48 mills were sold in 1888, 2,288 in 1889, 6,268 in 1890, 20,049 in 1891, and 60,000 projected for 1892. This was the heyday decade for erecting windmills. In 1889, there were 77 windmill factories in the United States; by 1919, the number had dwindled to 31. By the turn of the 20th century, Aermotor was producing 50% of the windmills in the United States, and they claimed to have sold over 800,000 windmills by the middle of the 20th century. Aermotor mills were still being manufactured in Broken Arrow, Oklahoma, until about 1970, when they moved to South America. By 1973, only 2 factories in the United States were still making complete old-fashioned ranch windmills. Several hundred mills are still sold each year. Storm damage to transmission lines, low voltages, and high utility rates have kept electric pumps from being the perfect alternative; gasoline engines need frequent fueling, and fuel costs keep climbing.

Today, windmills, parts, accessories, and repair services can be found on the Internet. Costs of windmills vary from about $3,000 for a 6-foot-diameter mill on a 21-foot tower to about $15,000 for a 16-foot-diameter mill on a 47-foot tower. Some farmers and ranchers continue to experiment with scrap metal and wood to make homemade windmills.

Uses of Windmills in Pumping

Besides providing boiler water for railroads, windmills sustained many rural homes, including water for elevated storage tanks at the house and troughs for livestock. Initially, ranchers used little logic in locating the mills across their wide expanses of land. However, as the marketing of cattle changed from a per-head basis to a per-pound basis, the weight loss of

Windmills and reservoir near Marfa in western Texas. Photo courtesy of the U.S. Geological Survey.

stock caused by long walks to water convinced ranchers to locate wells so that distances between watering places was reduced to a minimum. The goal was to place water sources so that cattle did not have to travel over 2 miles to water.

At the end of the 19th century, the Fairbanks, Morse and Company claimed that the famous 3-million-acre XIT ranch was using over 500 of its Eclipse mills. This was 1 windmill about every 3 miles, which was probably very good for such a large ranch. Besides pumping water, windmills were used for recreation by youngsters and as lighthouses on the plains. Lights were used to help people find their way home late at night. Windmill irrigation was important at a few locations. In times of drought, windmills were used as a backup source to stream-source irrigation and dryland farming. Windmills were used to drain marshes and swamps along some coastal areas and to remove water from shallow mines. Near Richmond, Missouri, an 18-foot Eclipse mill drained 11,000 gallons of water from a mine each day. Today, as remote areas are settled, especially by retirees, windmills are occasionally desired. The use of windmills brought about 2 of the most colorful characters of the West, the driller and the windmiller, and altered the lifestyle of another, the range rider.

The Role of Well Drillers

A necessary component of the windmill is the well beneath it. Settlers had to either dig wells by hand or hire so-called professional well diggers or drillers. The well digger was usually a loner and seldom seen by anyone except the range rider and windmiller. He followed the fence crews and, after guessing at where he might find water, bored wells with his horse-powered drilling rig. Many well diggers gave up on their 1st well, while others were renowned in their localities and spent much of their lives underground in the dangerous work of excavating and curbing wells. In most of the West, water was so deep that digging wells with shovels was not much of an option. Hand boring with an auger on a 1-inch-diameter rod was effective only to about 25–30 feet. Another shallow-water alternative involved men using sledgehammers to literally pound a pipe fitted with a special well point into the ground. A hollow metal point served as a sharp spike to ease its entry into the ground and as a strainer at the bottom of the well once it was completed. Both pounding and auger techniques were limited in areas with rocky formations.

On the plains and prairies and in desert areas, water was too deep to use any of these methods. Mechanical well-drilling machines were used. During the late 19th and 20th centuries, nearly all drill rigs were of the percussion type, called cable-tool rigs. These machines consisted of a heavy drill bit or other sharp tool fastened to a cable with a suitable derrick or tower for lifting it and then allowing it to drop. This forced a hole into the ground and pounded rocks into fragments small enough to be removed. The bits often weighed about 15–20 pounds. For shallow wells, manually operated wells could be used, but most used horsepower. As animals walked in a circle, the drill was raised on the end of the cable to a prescribed level and then, on release, plunged into the ground. A few stream-powered rigs were used in the late 19th and early 20th centuries, but they were expensive and required greater expertise. With time, rotary drilling rigs were used, but smaller operators have continued to use motorized percussion rigs to the present time.

The Hart & Company well-drilling outfit at Cliff, Nebraska, about 1890. Photo courtesy of Nebraska Historical Society.

As the hole was made, water was pored down the hole so that after the drill had pulverized some of the subsurface material, a bailer could be let down into the hole to remove the pulverized rock, soil, and water mixture. The process was repeated over and over until the water table was reached. Generally, the drilled wells were lined with iron casing to prevent them from caving in. The cost of drilling a well was not cheap. During the mid-1880s on the XIT Ranch in northern Texas, drillers received $1.50 per foot for the 1st 150 feet, $2.00 per foot for the next 100 feet, and then $0.50 more per foot for each subsequent 100 feet until satisfactory water flow was reached. A well in Nebraska was 444 feet deep and cost $600. Most old-time well drillers were solitary men who traveled across the country with their workers searching for business and then went about their mysterious work that few people understood. Much of their success depended on experience and familiarity with subsurface geological structure. Customers often were elated with their new wells, and their friends sent them congratulatory messages.

Maintenance and Repair

Initially, most mills were maintained by their owners. But hundreds of thousands of windmills in the West led to the need for maintenance and repair. Itinerant windmillers provided this service. These were often farm or ranch kids whose help was no longer as valuable because of the increasing mechanization of agriculture. They lubricated the mills, repaired pumping cylinders, repaired wind-damaged wheels and ironwork, replaced bearings, and fished out and repaired broken sucker rods. Their work was as important to the ranch as the doctor, veterinarian, or preacher. When the well digger was successful the windmiller followed and set up a mill. Owners of the larger ranches usually employed several windmillers to make continuous rounds, checking and repairing windmills. The windmillers lived in covered wagons and saw headquarters only once or twice a month. The early mills had to be greased twice a week, and this was the range rider's job. He kept a can (or beer bottle) containing grease tied to his saddle. When he rode up to a mill that was squeaking, he would climb it, hold the wheel with a pole until he could mount the platform, and then let the wheel turn while he poured grease over it. Whoever climbed the tower was always in danger of attacks from swarms of wasps, which hung their clustered hives beneath the windmill's platform; there was the added danger of falling from the tower when such attacks occurred. Windmillers' wagons were replaced by trucks in the 1920s and 1930s. Today, short courses in windmill maintenance and repair are taught at several places in the country, and online training programs are available.

Final Remarks

Artists often portray the rigors and failings of the Old West with paintings, sculptures, and photographs of windmills. Indeed, a shop at Old Town in Albuquerque, New Mexico, has only paintings of windmills. Invariably, their portrayals are of broken-down and dilapidated structures. These characterizations of windmills usually represent not failures but rather replacements by pumps powered with gasoline and electricity. Windmills brought settlement, development, and better times rather than failure. Indeed, on an outhouse wall behind a 1-room school in Cherry County, Nebraska, a child scribbled the following:

We like it in the sandhills,
We like it very good,
For the wind it pumps our water,
And the cows they chop our wood.

Several companies continue the manufacture of windmills in the United States. These firms include the Aermotor Windmill Company, Inc., of San Angelo, Texas; Dempster Industries, Inc., in Beatrice, Nebraska; Muller Industries, Inc., of Yankton, South Dakota; and KMP Pump Company in Earth, Texas. The American West Windmill Company in Amarillo, Texas, imports and distributes mills made in Argentina; Second Wind Windmill Service in Fort Worth, Texas, imports and sells mills made in Mexico; while O'Brock Windmill Distributors in North Benton, Ohio, imports and sells mills made in South Africa.

Authors are Habitat Restoration Biologist with the Utah Division of Wildlife Resources in Vernal (C. K. Wood), Graduate Student in mechanical engineering at the University of Utah (T. W. Wood), and Director of the Water Resources Research Institute at New Mexico State University (M. K. Wood).