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Article Summary: Irrigation made agricultural production possible in Great Plains areas receiving less than twenty inches of rainfall per year. Dry years created a demand for irrigation in areas farther east.

Cataloging Information:

Homemade Windmills: Jumbo, Merry-go-round, Battle-ax, Holland (Dutch), Mock Turbines, Giant Turbines

Factory-Made Mills: Dempster, Gause, Aeromotor

Pump Types: plunger (piston), vacuum, rotary, centrifugal

Manufacturers of Windmills/Pumps: Fairbanks-Morse, Thomson-Lewis, International Harvester, Dempster, Witte and Morris Machine Works

Nebraska Photographs / Images: a windmill plant in operation (Lucius M Wilcox, *Irrigation Farming*, 1907); irrigating pond and reconstructed mill near Ashland*; Battle-Ax mill in Dawson County*; Battle-Ax mill near Overton that cost $1.50 to construct*; large Jumbo mill used to irrigate Cushman Park Gardens, Lincoln*; a windmill irrigated farm garden in Chase County

*E H Barbour photograph, US Geological Survey

Tables: A: rates of pumping for the machine-made mill (from a 1962 article by E W Golding),
B: irrigation farming estimates made in 1907 (Lucius M Wilcox, *Irrigation Farming*)

WINDMILL AND PUMP IRRIGATION ON THE GREAT PLAINS 1890-1910

BY A. BOWER SAGESER

WALTER Prescott Webb speaking at Lincoln, Nebraska, in 1953 said that: "The windmill was like a flag marking the spot where a small victory had been won in the fight for water in an arid land."[1] When the dry years of the 1880's and 1890's struck the Great Plains, this mechanical device was put to work to irrigate the arid land. One of the earliest *modern* irrigation projects in Kansas was built in 1870 by soldiers at Fort Wallace on the Smoky Hill River to irrigate the fort's lawns and four acres of vegetables. A similar project was developed later by the soldiers at Fort Sidney, Nebraska.[2] Examples of windmill and pump irrigation plants can be found in the 1870's and the 1880's. By 1881, in Kansas, a slogan was developed for farms that could not be reached

1 Walter Prescott Webb, "The Story of Some Prairie Inventions," *Nebraska History,* (December, 1953), p. 232.

2 William C. Brady, "Kansas Pioneers in Irrigation," *Reclamation Era,* XXXIV, 109-112; *First Biennial Report, Nebraska State Board of Irrigation, 1895-96,* pp. 10-12.

Dr. A. Bower Sageser, Professor of History at Kansas State University, delivered this paper at The Western History Association meeting in El Paso, Texas on October 14, 1966.

by a stream or brook calling for "a windmill and a pond on every farm."[3]

Mother Nature might neglect to send the rains, but she had left vast reservoirs of underground water that might be utilized for irrigation if tapped by man. In a few areas farmers had drilled artesian wells which flowed freely, but in most cases the well had to be pumped by wind or other power.

Interest in irrigation in dry years rose like the barometer on a clear day. By 1892, after crop failures spread over the Great Plains, interest was revived and it took on the characteristics of a crusade which continued until late 1896 with the return of the rains. In plain fact, the farmer could not succeed in some areas of the Great Plains without resorting to irrigation. There were numerous forces at work which stimulated this new interest. Drought, population exodus, low prices, tax rates as well as railroad rates, unemployment and many others kept up the desire for better irrigation practices. By this time, Francis H. Newell's surveys of water resources in the United States had been made and Secretary of Agriculture Jeremiah M. Rusk showed great interest in the survey of possible underflow and artesian waters.[4] Irrigation associations at local, state and national levels were formed and frequent meetings held. The general press and numerous periodicals gave ample space to the problems and new methods of irrigation. Especially valuable were periodicals devoted entirely to the cause of irrigation, as Joseph L. Bristow's *Irrigation Farmer* and William Smythe's *Irrigation Age.*

To areas receiving less than 20 inches of rainfall per year, and not properly distributed during the late growing season, irrigation became the life and salvation. Dry years

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[3] *Topeka Commonwealth,* September 7, 1881; May 23, 1882.

[4] See Francis H. Newell's *Report on Agriculture by Irrigation in the Western Part of the United States,* published as part of the *Eleventh Census of the U. S.,* 1890; Richard J. Hinton's *Progress Report on Irrigation in the U. S.* prepared under the direction of the Secretary of Agriculture (Washington, 1891).

pushed the areas needing irrigation eastward. The growing interest in this new type of farming can be seen in the private applications for the use of water from Nebraska's streams and rivers. Nebraskans adopted their first general irrigation law in 1889. Prior to 1895, some 1000 claims were recorded. Under a second law of 1895, six hundred ninety-four applications were made in a single year. The rains returned in 1896 and 1897, and the number of applications was greatly reduced. By 1904, the State Board of Irrigation was cancelling undeveloped claims at the rate of 150 per year. Judge J. S. Emery, a national lecturer on irrigation, described the Kansas interest in 1894, writing that, "Kansas has her head and tail up, and irrigation is a go."[5]

The years of 1890-1896 might be called the experimental years for the use of the windmill in irrigation. It was during these years that the factory and homemade mills were put to work. Some farmers made more from a single mill than their neighbors were able to make on 160 acres. Others produced more foodstuffs on one acre than on the remaining quarter section.[6] In the Platte River and Arkansas River valleys the settlers were fortunate to find that the underground water (usually called underflow) could be reached with shallow wells only 8 to 30 feet in depth. Here a mill, even of low efficiency, could easily be applied to irrigate a few acres of land and produce a variety of crops. Some commercial mills were developed, but there was a genuine industrial lag in this area until around 1898, and they were expensive for the times. The editor of the *Irrigation Age* admonished the farmer, "if you can't buy one, make one."[7] The farmer, accustomed to developing farm machines to fit his particular need, turned to the homemade mill. Erwin H. Barbour, a distinguished Nebraska geologist, found seven main classes of these mills

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[5] *Fourth Biennial Report, Nebraska State Board of Irrigation, 1901-02*, p. 222; *Irrigation Age*, VIII, 4 (January, 1885).

[6] Webb, *op. cit.*, pp. 242-243; *First Biennial Report, Nebraska State Board of Irrigation, 1895-96*, p. 10.

[7] *Irrigation Age*, XI, 15-16 (January, 1897).

and twenty varieties in his study in 1898.[8] With scrap material from the farm, lumber, castings and bearings from discarded farm machines, iron rods, canvas and even tin cans, the farmer designed his own source of power. The costs ranged from $1.50 upwards. Farmers not only used this type of mill for pumping water, but also for other sources of power as grinding and operating farm tools, even tools in the blacksmith shop. In some cases the homemade mill was a necessity, but it frequently became a convenience and a luxury, built by well-to-do farmers. It was not unusual to find three or four of these mills pumping water in a single pasture. Today, the federal government subsidizes the farmer for the costs of such wells to keep the cattle from wearing off the fat in a long trek to a water source. The editor of the *Kansas Farmer* wrote on May 28, 1908: "Like the sod house the Jumbo windmill was useful for its day, but for the average farmer that day has long since passed." This mill had become a "has been" of pioneer times.

The names of the homemade mill, soon spread across the frontier, included Jumbos (medium giant and screw), Merry-go-round (including mounted and unmounted forms), Battle-Ax mills with two to eight battle axes, Holland or Dutch mills, Mock turbines closely resembling shop made mills with 4, 6, 8-20, 50 fans, and Giant Turbines, some vaneless, reconstructed turbines with or without rudders.[9]

For upland farms with deeper wells the factory-made mill was more efficient. These were widely used in the eastern Great Plains area. When the Kansas Irrigation Board developed twenty experimental wells in western Kansas in 1895-1896, only one was powered by a ten horsepower gasoline engine furnished by the Fairbanks Morse Company. Nineteen were pumped initially by windmills.[10]

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[8] Erwin H. Barbour, "The Homemade Windmills of Nebraska," Article V in *Bulletin of the U. S. Agricultural Experiment Station of Nebraska,* XI (1899).

[9] *Ibid,* p. 11.

[10] A. Bower Sageser, "Editor Bristow and the Great Plains Irrigation Revival of the 1890's," *Journal of the West,* III, 86-87.

Some wells could not be pumped continuously with the large mills used by the state. Finney County in 1894 had over 100 pumping plants, mostly wind-powered.[11] By 1910, many types of factory-made mills were for sale. Irrigation boards and state agricultural colleges were still urging their use. The leaders were the Dempster, the Gause, the Aeromotor; others were the Ideal, Crane, Fairbanks-Morse, Double-Header-Challenger, Cyclone, Eclipse, Woodmansee, Carlyle, Halladay, Corcoran, Althouse, Gem, Perkins, Stover and Buchanan. Most of these could be found among the county fair exhibits.[12]

The farmer could make his homemade mill, but he was never freed completely from factory or shopmade equipment for his irrigation plant. Several firms manufactured sandpoints, but on occasion the farmer made his own or improved upon the machine made point. This consisted of a sickle knife welded on the end of a perforated pipe with the pipe wrapped with screen. Almost always the farmer purchased a cylinder and valves that were factory made. He was likewise dependent on the itinerant well driller to put down his well at a cost of 50c to $1.50 a foot.

No matter how good a mill the farmer built or bought, it was not in itself a satisfactory system unless a reservoir was built. Water piped directly to the crop land sank in too rapidly. The reservoir enabled the farmer to deliver water to a much larger area. Here the science of reservoir building developed quickly. With the reservoirs, the mill could run day and night and when the water was turned on to the soil it moved more rapidly. Many reservoirs, 60 feet wide and 100 feet long, were located on higher ground. Retaining walls ranged from three to five feet in height. In order to check water seepage some walls were 8 to 12 feet wide at the bottom and the inside lined with clay or brush to check wave erosion. Some reservoirs ranged from one to three acres. The bottom of the reservoir was com-

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[11] *Ibid,* p. 82.

[12] Names of mills were gathered from advertisements of the time.

pacted to make the soil less porous. Often the earthen floor was covered with water and horses or cattle were driven around on the floor through a regular loblolly until the area was firmly packed. Usually a clay tile or wooden pipe was used as an outlet. Some farmers practiced winter irrigation. Others stored ice from the pond for summer use. A few stocked the reservoirs with fish.[13]

In most cases, areas irrigated by the windmill ranged from two to five acres. I. L. Diesem at Garden City irrigated fifteen acres during the summer of 1894 from two reservoirs. An eight inch pump was powered by a fourteen foot mill which produced 4,400 barrels of water per day. One reservoir was eighty feet wide and one hundred fifty feet long; the other was sixty by one hundred feet. Diesem had eight acres in orchard and produced garden vegetables and berries on the remainder of the fifteen acre tract. Not far from Diesem's farm, D. M. Frost had twenty acres of vegetables irrigated by two windmills. One mill was a standard make, the other an "over-shot" or "Great Mogul." He claimed the latter with a reservoir was the cheapest.[14] Estimates on pumping capacity and acres irrigated were often over-optimistic. The following table, A, shows rates of pumping for the machine made mill.[15]

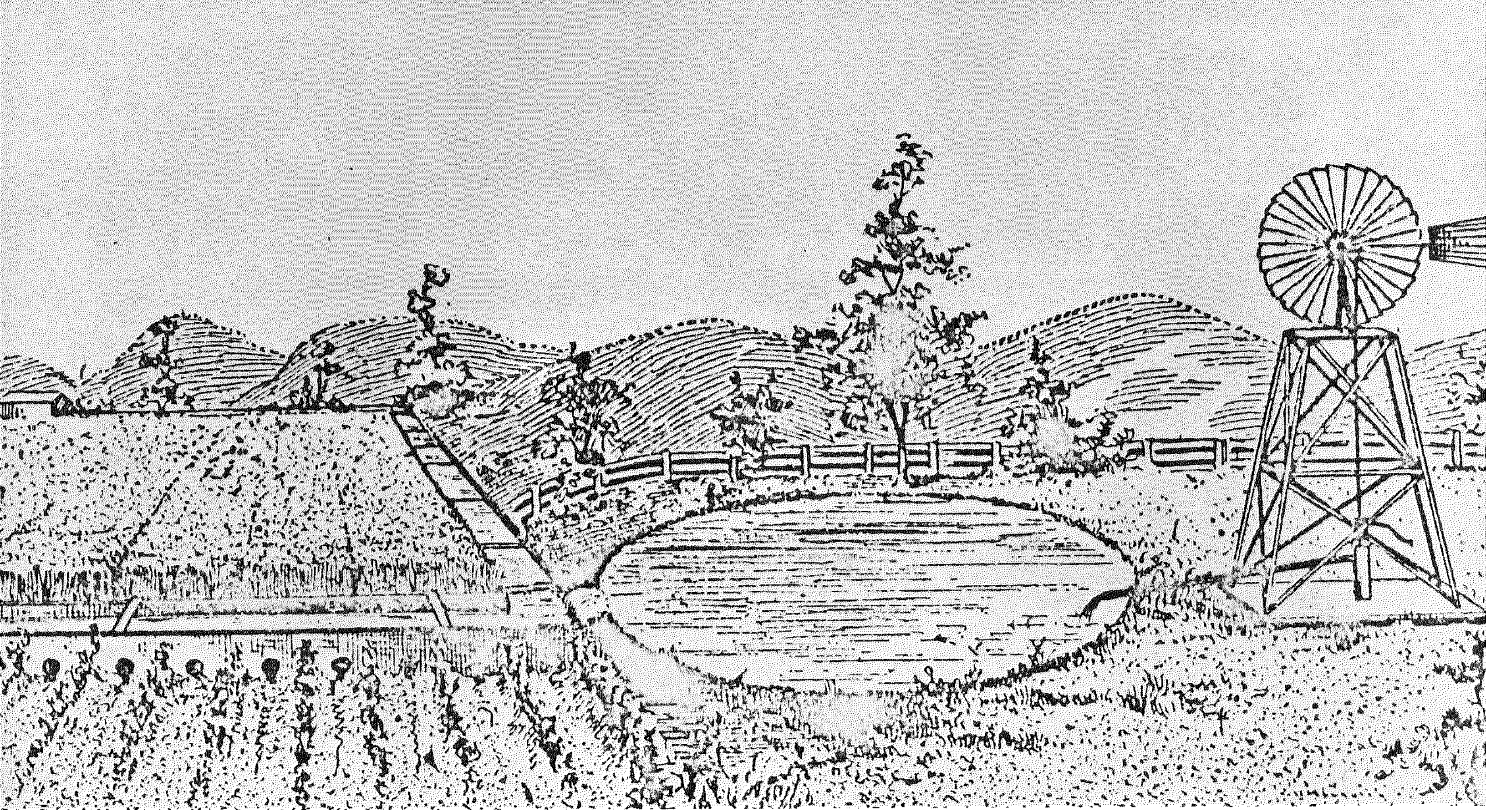
TABLE A

Wind speed in m.p.h.	6 ft. mill gal. per hr.	10 ft. mill gal. per hr.	14 ft. mill gal. per hr.
7	25	72	138
10	75	200	400
16	306	860	1660
20	594	1660	3200

[13] *Irrigation Age,* XVII, 72-73; Sageser, "Editor Bristow and the Great Plains Irrigation Revival of the 1890's," *Journal of the West,* III, 84.

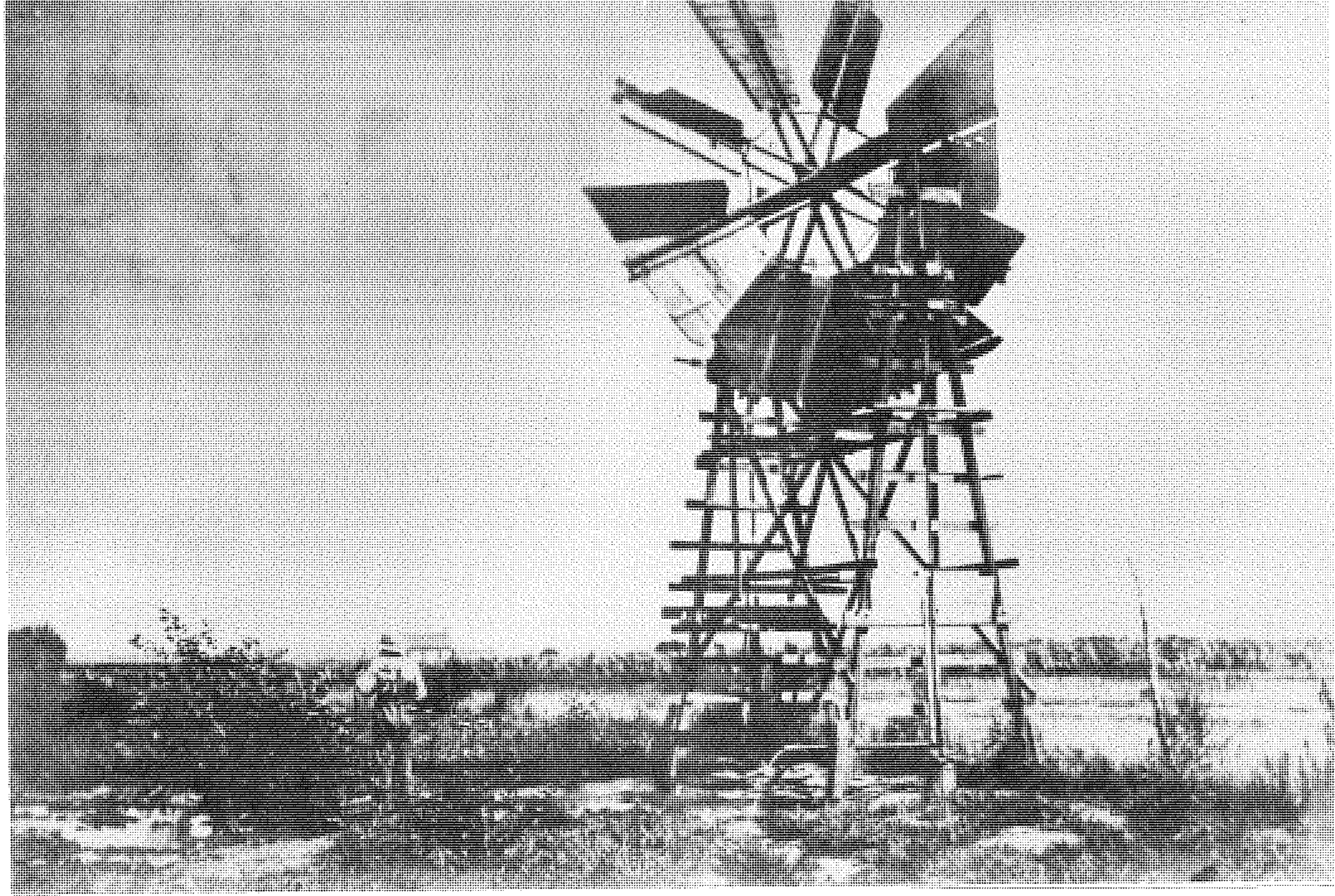
[14] *Ibid,* p. 85.

[15] E. W. Golding, "Water Pumping and Electricity From Windmills," *Agriculture,* LXIX, 23 (April, 1962). Another estimate by A. E. Wright and A. B. Collins in *United States Department of Agriculture, Office of Experiment Stations Bulletin, No. 158, 1905,* pp. 585-594, shows 6 eight foot mills irrigating 2.1 acres; 11 ten foot mills irrigating 4.1 acres, 13 twelve foot mills irrigating 5.8 acres (each) in the Garden City, Kansas, area.

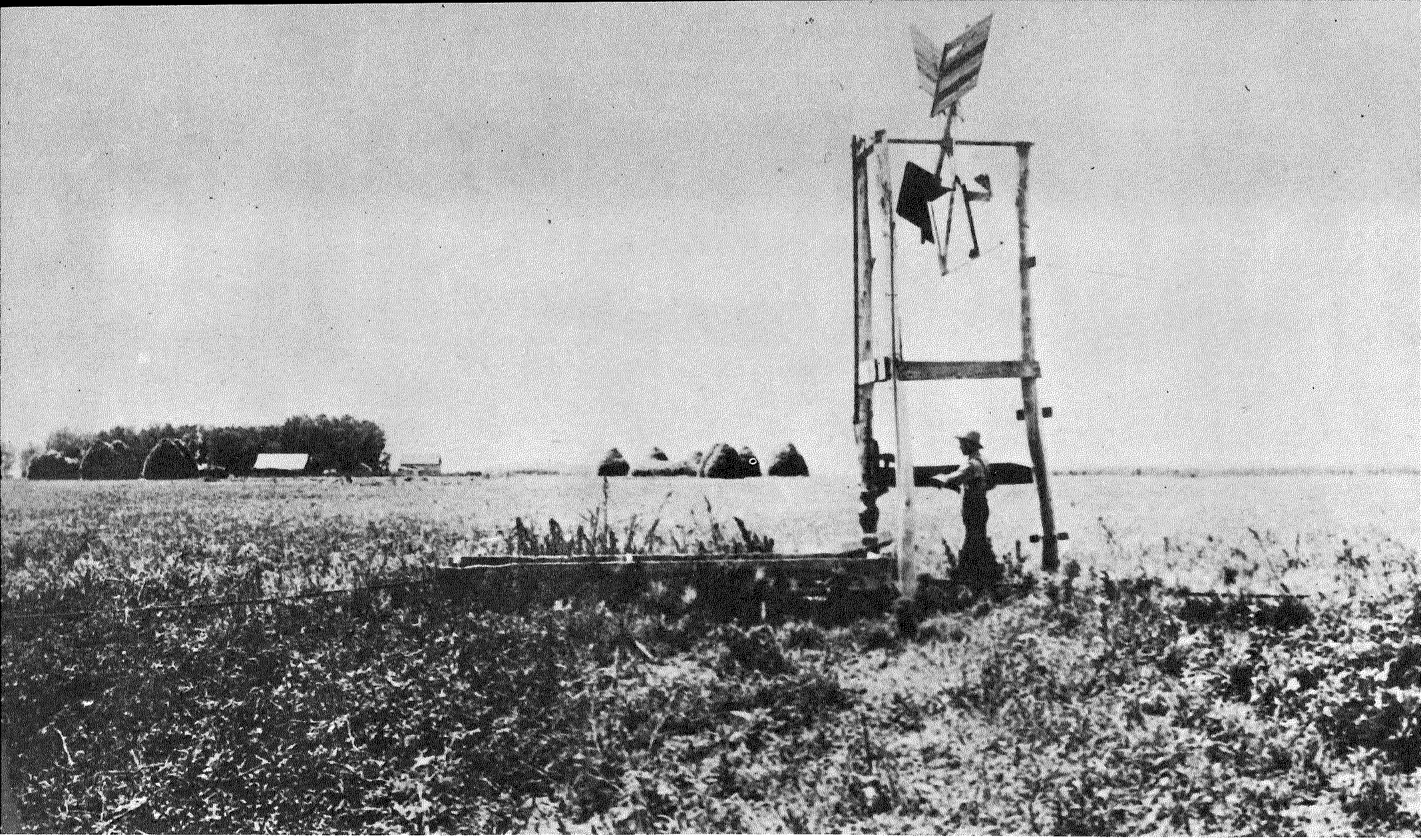


A windmill plant in operation.
From Lucius M. Wilcox, **Irrigation Farming** (N. Y., 1907).

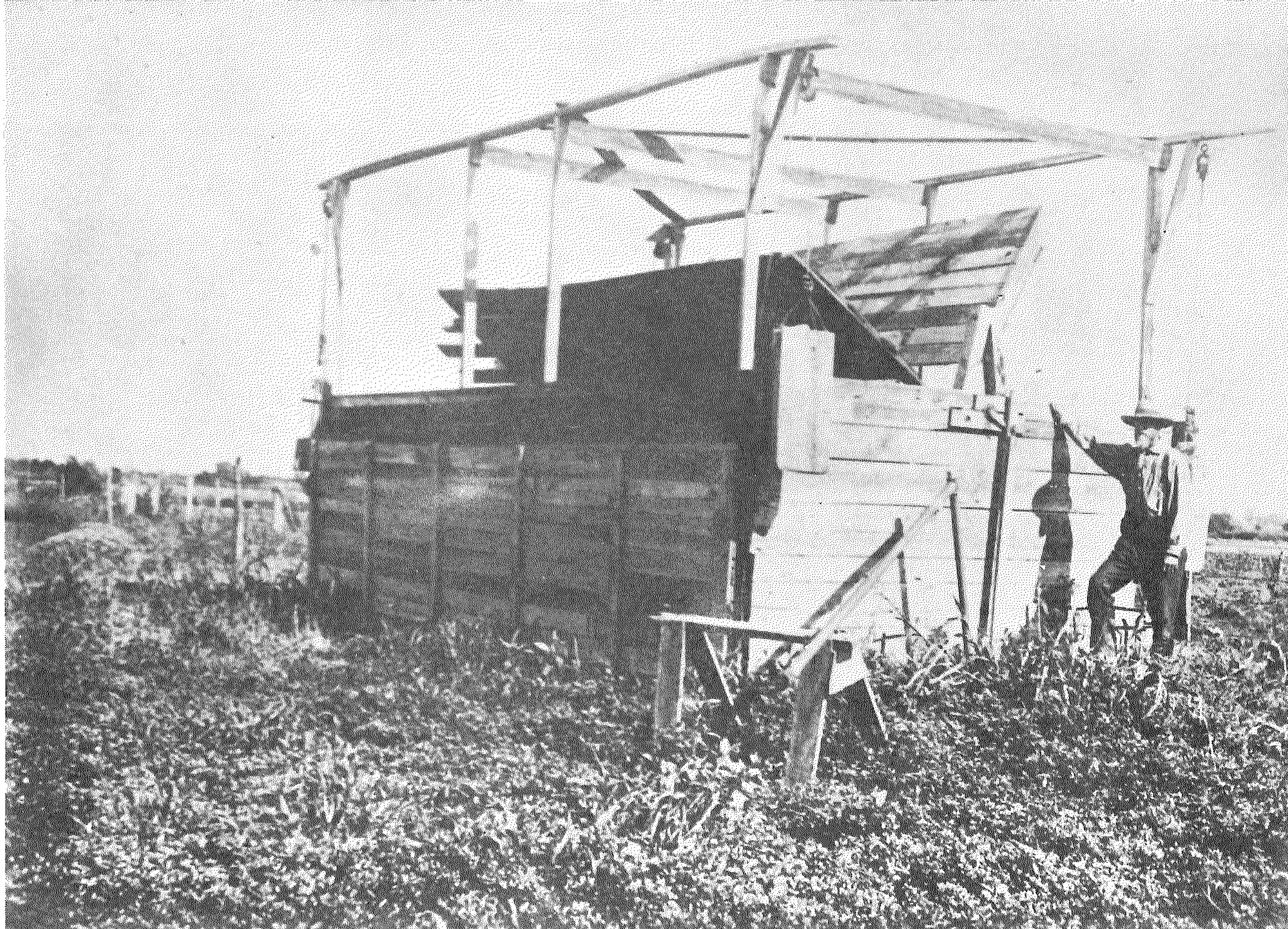
Irrigating pond and reconstructed mill near Ashland, Nebraska.



Battle-ax mill in Dawson County, Nebraska,



This battle-ax mill near Overton, Nebraska cost $1.50 to construct.



Large jumbo mill used to irrigate Cushman Park gardens, Lincoln, Nebraska.

A windmill irrigated farm garden in Chase County Nebraska.

TABLE B

IRRIGATION FARMING

Size of mill, in feet	Diameter of pump cylinder, in inches	Depth of well in feet	Length of mill stroke, in inches	Number gallons of water at each stroke	Amount of water per hour, in gallons	Amount of water in 24 hours, in gallons	Amount of land that can be covered one one foot deep by mills working for 300 days in the year at the rate of fifteen hours per day, acres covered	Size of reservoir capable of holding water for twenty-four hours continuous pumping on estimate given. Reservoir 4 feet deep; banks 16 feet base, 5 feet high—interior size
10	8	30	10	1½	3,600	87,840	....	....
10	6	50	10	1¼	2,580	61,920	....	....
10	4	75	10	⅝	1,320	31,680	....	....
12	10	30	12	4½	7,500	180,000	103 acres	90 by 75 feet
12	8	50	12	3½	6,300	151,200	86 acres	90 by 60 feet
12	6	75	12	1½	2,700	64,800	37 acres	60 by 40 feet
12	4	125	12	¾	1,320	31,680	18 acres	50 by 30 feet
14	12	30	14	6⅓	10,620	254,880	146 acres	125 by 80 feet
14	10	50	14	4⅓	7,260	174,240	100 acres	90 by 75 feet
14	8	75	14	2¾	4,620	100,880	63 acres	75 by 50 feet
14	6	125	14	1¾	2,940	71,560	40 acres	65 by 40 feet
14	4	175	14	1	1,680	40,320	23 acres	50 by 30 feet
16	5	200	16	1½	1,700	47,680	25 acres	50 by 35 feet

Reproduced from Lucius M. Wilcox, *Irrigation Farming* (N. Y., 1907), p. 364.

Table B. shows Wilcox's estimates made in 1907. The acreage is no doubt too high.[16]

The extent of the use of the windmill is difficult to determine. Estimates vary and were no doubt too high. Nebraska, Kansas and eastern Colorado were leaders in the use of the underground resources. One estimate in 1898 credits Nebraska with 2000 private systems using the windmill. Records kept in 1904 on the performance of 72 windmills at Garden City ranged from one fourth an acre to seven acres. There had been no single crop failure in the previous ten years where a windmill provided mois-

16 Table reproduced from Lucius M. Wilcox, *Irrigation Farming* (New York, 1907) p. 364.

ture.[17] Writers frequently spoke of the mill as a prime mover, which enabled the farmer to succeed. Much had been gained in this experimental era. Dry lands which could not be reached by streams and canals were irrigated. Crop yields had been doubled and at times quadrupled. Crops were diversified. It was great news when a farmer at Ord, Nebraska, produced 105 bushels of barley to an acre. The diet of farm families was greatly improved. At least one enthusiast predicted that irrigation would do away with patent medicine and M.D.'s.[18] For some farmers the mill had been a means of survival. Moreover, its use had generated dreams of a new Utopia, stimulated state experiment stations, the adoption of state paid irrigation engineers, and the passage of better state irrigation codes. More was learned of the supply of underground water. Old superstitions on the harmful effect of ground water on crops were destroyed. Experiments with the windmill were to continue. In Kansas, $125,000 a year was appropriated as late as 1915 for windmill experiments and six western counties bought 160 acre tracts and donated them for the state experiments. But the windmill did not bring large scale irrigation. It was not until bigger pumps, deeper wells, and new sources of power were put into use that well irrigation really flourished. Then, and only then, could the farmer irrigate forty to eighty acre tracts from a well. The years 1897 to 1910 might well be called the years of adolescence for pump irrigation.

By 1910, irrigation by larger capacity pumps was a flourishing business, both for the farmer and the manufacturer. Deeper and more productive wells could be de-

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[17] *Yearbook of the United States Department of Agriculture, 1905,* p. 431. This report estimates 750,000 acres irrigated by wells. This included irrigation for rice. Some 200,000 acres of this total were in California.

[18] *Irrigation Age,* XIII, 428-29; *Sixth Biennial Report of the Commission of Forestry and Irrigation* (Kansas, 1898) pp. 47 ff. E. D. Wheeler wrote that irrigation "will give a healthful appetite for fresh fruits and vegetables, and at the same time ruin the patent medicine business and drive doctors to change their business or leave the country."

veloped. Many irrigators used 6 to 36 inch well casings and it was not unusual to find wells 200 feet in depth. Pumps were powered by engines ranging from 2 to 400 horsepower. The engines were fueled by gasoline, distillate, and steam. A few pumps were driven by compressed air, and by 1910 electric motors were in use on many irrigation systems.[19]

Four distinct types of pumps were manufactured: the plunger or piston, the vacuum, the rotary, and the centrifugal. In a few wells, lakes and reservoirs a chain-bucket elevator was used. On occasion, the hydraulic ram was put to use. The centrifugal pump, freed from the use of valves that might stick, was the most efficient. A good propeller or centrifugal pump delivered from 400 to 6000 gallons per minute. An abundant supply of underground water enabled the new pumps to flow continuously.[20] This eliminated the reservoir which was so necessary for irrigation by windmill.

Many of the leading manufacturers of windmills turned to the production of engines and pumps. Fairbanks-Morse, Thomson-Lewis, International Harvester, Dempster, Witte, and Morris Machine Works all produced engines and pumps. Other pumps were the Van Wie, Newell & Murphy, Victor Turbine, Jeffry Chain and Bucket Pump, Link-Belt Water Wheel, and the Tubular-Propeller Pump pioneered by A. T. Ames at Galt, California. This last pump produced 20,000 gallons per hour, using a 12-inch bored well 200 feet deep.[21] These power driven pumps

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19 Putnam E. Bates wrote in the *Scientific American* for May 24, 1913: "So it is seen that scientific agriculture, irrigation and electricity have formed a powerful combination." (vol. 108, p. 279).

20 Lucius M. Wilcox, *Irrigation Farming* (New York, 1907) p. 3 ff. gives detailed descriptions on the types of pumps in use. See also John G. Haney, *U.S.D.A. Office of Experiment Stations,* Bulletin, 158, pp. 567-583 on "Irrigation Experiments at Fort Hays, Kansas, 1903-1904." An English work is also valuable, written by Sir Handbury Brown, *Irrigation: Its Principles and Practices as a Branch of Engineering* (New York, 1912).

21 Company names compiled from current literature. The Ames pump is described in *Irrigation Age,* XIX, 84-85 (November, 1903).

were not always used with large casing wells. In some areas the farmer drove several sand points, usually 1½ to 2 inches in diameter, several yards apart and connected these smaller wells above the ground with a large pipe attached to a pump. Several of these systems are in use in the Arkansas River valley today.

Many examples of new plants can be found. At Garden City, located in Finney County, Kansas, the United States Sugar and Land Company irrigated 3,500 acres, using a 400 hp. engine to run a 350 kilowatt generator. Through 20 miles of electric line, fourteen pumping plants were operated each with a capacity of 1800 to 2000 gallons per minute. In 1911, Finney County, Kansas, had 6500 acres of land irrigated by centrifugal pumps which were powered by gasoline or distillate. With the pumps as with the windmill, the river valley farms were the first to be irrigated.[22]

While the United States census reports for 1910 on the use of wells for irrigation are not complete, some trends can be seen. By 1909, 13,738,485 acres of land were under some form of irrigation. In the seventeen arid and semi-arid states there were 14,558 wells being pumped, irrigating 477,625 acres. This total does not include the use of pumps for streams, lakes or reservoirs. In Kansas today, 72 per cent of the land irrigated is watered by the use of pumps. The pumping capacity of the 14,558 wells was 9,918,775 gallons per minute. In 1909, the five leading states in the number of pumped wells, in order, were California, Kansas, Arizona, New Mexico, and Texas. This report did not include the wells in Texas that were used to irrigate rice. The greatest use of wells was east of the Continental Divide and in southern California. Wyoming reported 3 pumped wells, Utah 27, Montana 10, Colorado 121, Idaho 24, Nebraska 66, and Oklahoma 69. The total

[22] J. C. Mohler, "Driven to Tap," *Country Gentleman,* LXXVII, p. 6 ff.; *Eighteenth Biennial Report of the State Board of Agriculture, Kansas, 1911-1912,* XXIII, 64 ff.

acreage in these states was not large.[23] Deep wells and big pumps were costly. The irrigator had to be a man of fair means or of good credit to pay from $12.00 to $25.00 per acre for his plant. It was easy to invest $1000 to $3000 in a project, and land values soared where deep well irrigation was possible.

The impact of the big pump and deep well was much the same as the windmill. The more productive wells freed the farmer from the interstate rivalry over the use of the streams. There was more diversification of crops and more experiments at state and national levels. For example, the national government provided one experiment for the production of tea.[24] Technology had responded to meet almost every need of the irrigation farmer.

Some farmers looked upon irrigation as a lazy man's way. The irrigator could just provide the water and let it run. Experience showed that this was not true. Irrigation became "a way of life," and it was hard work.[25] Francis H. Newell had stressed that the "ideal" was forty acres in the irrigated country. But he also added that the irrigated country was no place for the poor farmer. According to Newell, the man who goes to the irrigated country "must use his brains in all his farming."[26] There was an extensive amount of published information for the irrigation farmer by 1910. Of course, there was always the academic argument in the arid lands between those who favored farming by water and those who supported "dry farming" or "horse-leg irrigation" because water was conserved by tillage.[27]

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23 Material compiled from *Thirteenth Census of the United States, Agriculture;* W. H. Olin, *American Irrigation Farming* (Chicago, 1913) p. 326; Arthur Hooker, ed., *Official Proceedings of the Nineteenth National Irrigation Congress* (Chicago, 1912) p. 37.

24 For the tea project see *Irrigation Age,* XIV, 31.

25 Carl Frederick Kraenzel, *Great Plains in Transition* (Norman, 1955), p. 260-263.

26 *Irrigation Age,* XXVI, 638 ff.

27 *Nebraska History,* XXIV, 286, gives name of "horse-leg."

By 1910, a farmer knew the real value of well irrigation. The system would be extended throughout the land wherever a supply of underground water could be found. With adequate finance the farmer could always escape the effects of the droughts through well irrigation. Authors of the U.S.D.A. Experiment Station bulletins for the period of 1908-1910 still referred to pump irrigation being in or just past its infancy. But all predicted that pumping plants would reclaim much arid land in the future.[28] Certainly, the irrigator of the past two decades owes much to the experiments which took place from 1890 to 1910. So influential was this new way of life that the natives in their moments of relaxation often ordered "Ditch and Bourbon" from their favorite bar-keeper.

[28] E. W. Beach and P. J. Preston, *Irrigation in Colorado,* Bulletin 218, pp. 30-35; V. L. Sullivan, *Irrigation in New Mexico,* Bulletin 215, p. 41; Don H. Bark, *Irrigation in Kansas,* Bulletin 211, p. 27.