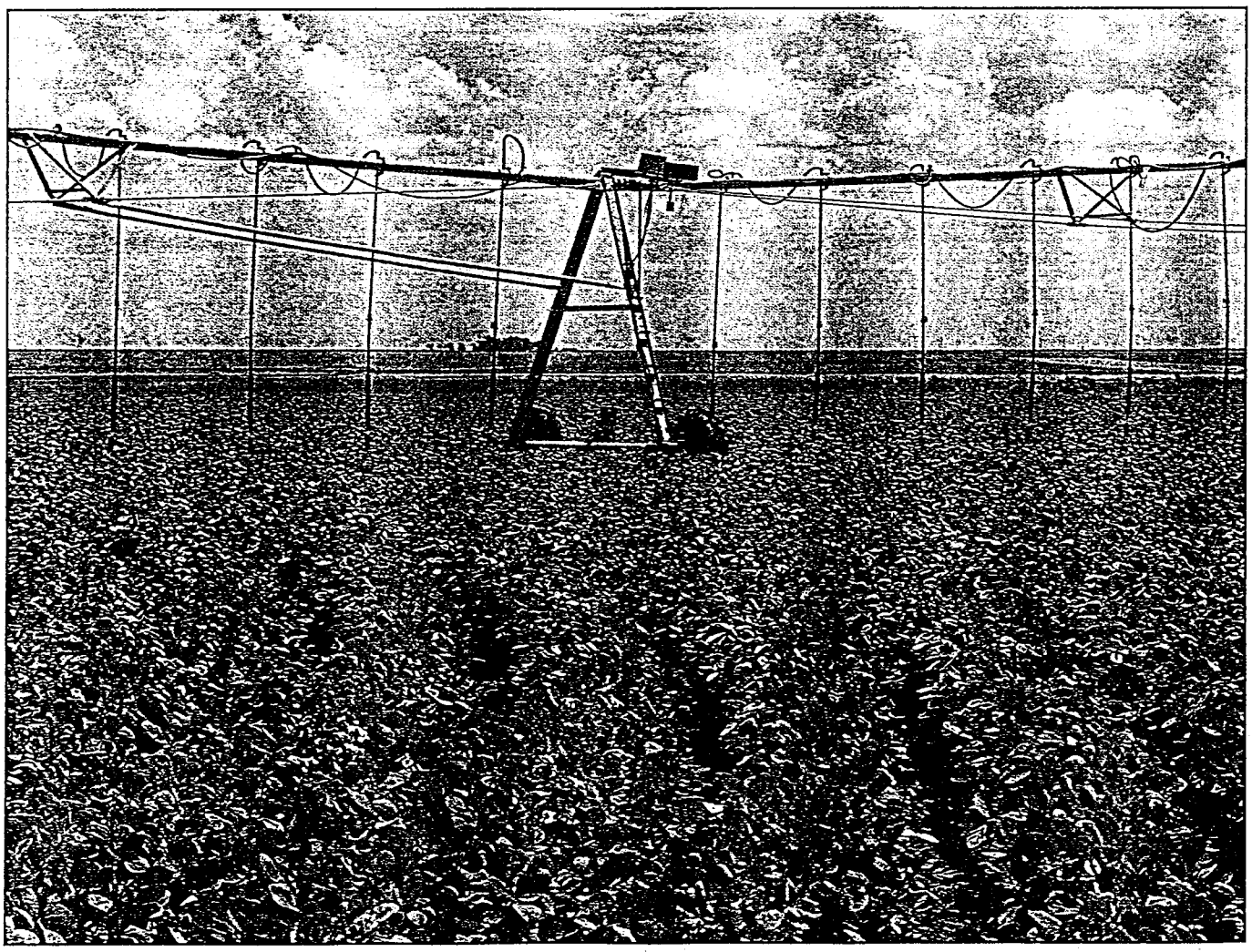
Drops of life in the history of irrigation

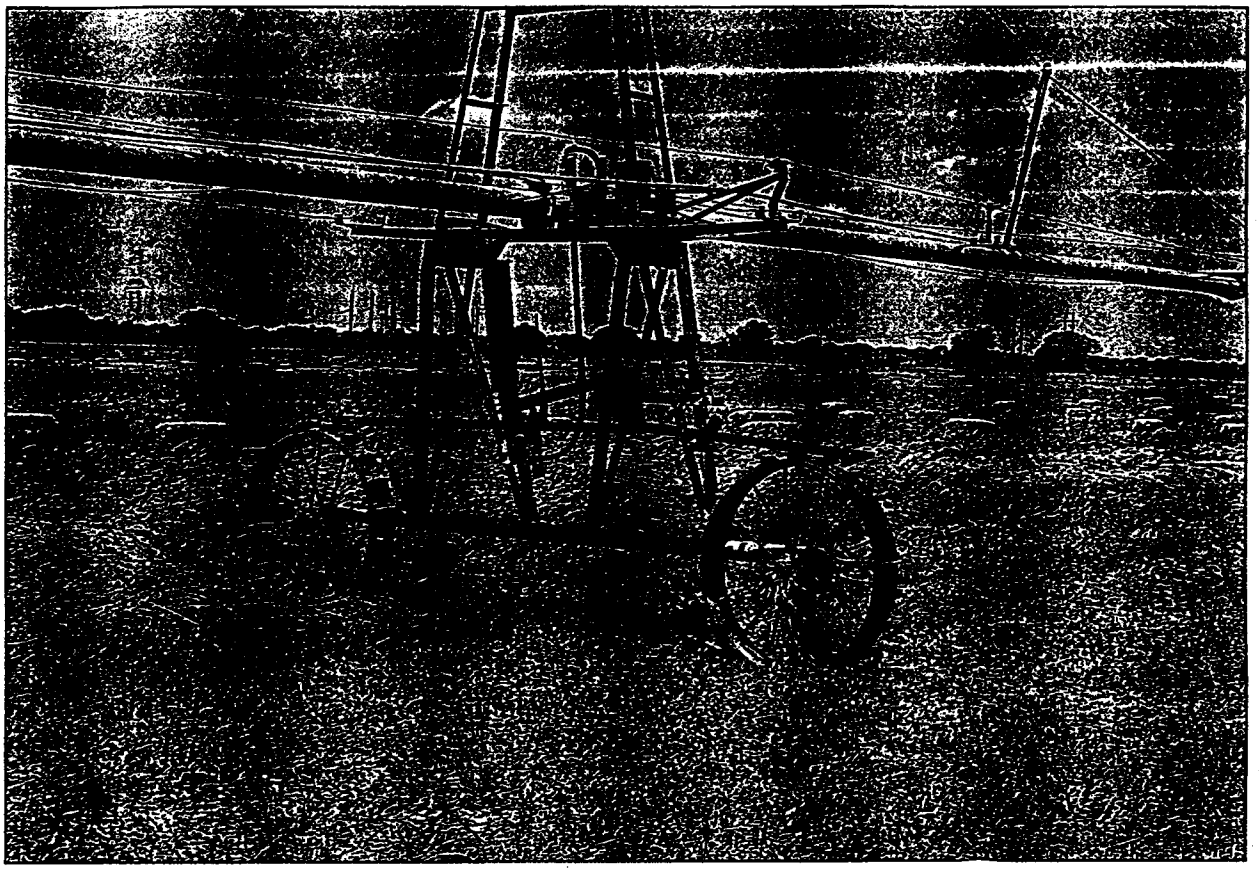
By Terry Howell

It is always interesting and insightful to take stock of where our roots lead. Irrigation at the beginning of the year 2000 scarcely resembles the developing industry in the late 1940s after World War II. One of the few similarities is the people within the industry. Many descendants of industry pioneers remain strongly committed to the manufacture and sale of irrigation equipment. I still have my dad's copy of his Rain Bird *Sprinkler Irrigation Handbook* safely stored in my file cabinet that remains a personal keepsake along with his handwritten notes in the margins. This brief glimpse back in time is focused on sprinkler, mechanical-move sprinkler, and drip irrigation systems.

Sprinkler irrigation developed as a method that did not depend on the soil as the water distributing medium. It primarily used pipelines conveying water under pressure and various spray techniques to evenly apply water to undulating land that was not well suited to leveling techniques commonly used for surface irrigation. Drip, trickle, and various microsprays—now called microirrigation—initially developed with goals similar to those of sprinkler irrigation. Microirrigation, however, was designed to apply water evenly to individual plants, such as in an orchard or vineyard, on a frequent basis (daily in most cases).



A center pivot using LEPA drops (drag hoses) on a soybean field in Bushland, TX.



An early water drive tower of a center pivot produced by Valley Mfg.

Sprinklers

Sprinkler technology has been used for more than a century. An interesting piece of irrigation history is the role that farmers have played in inventing irrigation equipment. In 1894, Charles Skinner, an Ohio farmer, patented the Skinner System which was widely used into the early 20th century. Although sprinkler devices rapidly advanced, one of the first successful vertical-impact sprinklers was manufactured by Fingel C. Orr of Los Angeles. The Buckner Co., founded by W.A. Buckner in Fresno, CA, later bought the concept and developed an early turf rotating sprinkler head (first used on Pebble Beach Golf Course). The Rain Bird impact sprinkler, developed by farmer Orten Englehardt from Glendora, CA, revolutionized agricultural sprinkler irrigation. Equally important to the sprinkler development was the development of portable, thin-walled pipes with quick coupling devices. The rubber gasket, pioneered by Ralph H. Pierce, provided a tight seal at moderate pressures and permitted connecting portable-pipes. This gasket proved more important when aluminum tubing, following World War II, became available and economical. These technologies still provide the backbone of our portable hand-move and solid-set sprinkler systems today.

Mechanical-Move Sprinklers

Sprinkler technologies moved into laterals with wheels early. Pioneers, like Harry Firestone, developed a rubber-tired wheel line in the 1930s. The more commonly recognized side-

roll systems like those from the R.M. Wade Co. of Portland, OR and many types of mechanized side-roll systems were developed and are still widely used. Even the highly acclaimed inventor Arthur E. Jensen, who invented the Sunbeam Electric Shaver and a barometric bomb fuse, developed a planetary gear transmission to drive a side-roll system and the counterbalanced sprinkler base for side-roll sprinkler systems.

Center Pivots

Dr. William Splinter called the center-pivot sprinkler "the most significant mechanical innovation since the replacement of draft animals by the tractor." His opinion is confirmed on any clear day when flying over the Northwestern U.S. or the Great Plains and seeing the many green circles and half-circles that appear below. In 1952, Frank Zybach, a Colorado farmer, patented a self-propelled center pivot overhead sprinkler that used a water drive mechanism. Zybach and his manufacturing partner, A.E. Trowbridge, eventually sold their marketing rights to Valley Manufacturing (now Valmont Industries). Although half mile long pivots are common in many locations now, the one-quarter mile long center-pivots are more typical.

In the 30 years following World War II, more than 60 manufacturing companies built center pivot machines. Today, only about a dozen center pivot companies actively manufacture the machines. Tremendous changes have occurred in center pivot application technologies. Early center pivots used fixed-spacing or variable-spacing, high-angle impact-sprinklers (double or single nozzles) with the former requiring progressively larger sprinklers (and/or nozzles). Currently, lower-angle impact-sprinklers or drop lines with spray heads with a variety of applicators and spacings from fixed sprays to drag lines are often used. Two of the companies that manufacture application products for center-pivot applications are Senninger Irrigation and Nelson Irrigation Corp. Senninger Irrigation was developed by Joe Senninger a Florida citrus grower. Nelson Irrigation Corp. (located today in Walla Walla, WA) is headed by Bart Nelson, grandson of L. R. Nelson who formed the Nelson and Morrison Manufacturing Co. in 1906 in Boulder, CO.

Center-pivots only irrigate about 78 percent of the land surface, so they are ideally suited to areas with limited water and ample arable land, such as the U.S. Northwest or Great Plains. A greater proportion of the surface land area can be irrigated by using end guns to reach the corners, by cornering center pivot machines, or even by squeezing the circles into a hexagonal pattern. By the 1970s, center pivots had changed to mainly electric or hydraulic drives, greatly improving their reliability. The structural designs had changed to under truss supports rather than tower cable supports. The under truss systems are better adapted to taller crops like corn or sugarcane. Towers now mainly use pneumatic tires of various widths and diameters. Tire flotation and system support are critical in avoiding deep rutting and traction problems.

LEPA & TTIS

Dr. Bill Lyle, a researcher and farmer in Texas, developed Low Energy Precision Application (LEPA) that embodied both furrow dikes to impound the applied water temporally along with any rainfall. Although Lyle's early systems applied water to every furrow, he soon recognized that alternating furrows with bubble applicators was equally effective. This wet the soil deeper and further reduced soil-water evaporation. Dr. Del Fangmeier from Arizona developed a double-ended drag sock to spill water on both sides of the furrow dike without washing out the dike itself. Due to the soil friction, a single-ended drag sock will also work effectively and more simply to avoid washing and eroding the furrow dikes. These basins would easily store almost 1-1/2 to 2 inches of rainfall (covering the whole area) and 3/4 to 1 inch of irrigation water applied to alternate furrows. LEPA was designed to capture all the rain, reduce any sprinkler droplet evaporation, eliminate runoff, and to minimize deep percolation by applying only the water needed by the crop. LEPA is ideally suited to the Southern High Plains with center pivots with small irrigation capacities (flow rate per unit land area; i.e. 2-5 gpm/ac). Of course with center pivots, LEPA worked best with circular planted rows. In California, Dr. Claude Phene developed a similar concept called the Traveling Trickle Irrigation System (TTIS). Much like LEPA, TTIS was designed to move drip/trickle irrigation technology to large-scale mechanical irrigation.

Lateral Move Sprinklers

Lateral-move (or linear-move) sprinklers were adapted from center pivot technology to irrigate an entire area, not just a circle. Wade Manufacturing developed a winch driven main tower attached to a pivot lateral (called the Square Matic) in 1970 that moved the pivot technology into the lateral-move arena to irrigate almost all of a square or rectangular field. Tumac Industry of Colorado Springs produced lateral-move irrigation machines that could use ditch supplies or hose feeds. Both ditch-fed and hose-fed lateral-move machines are readily available from many manufacturers. Lateral-moves can have end- or center-feed arrangements and are more adapted to fully irrigated crops than the pivots because they have a lower peak instantaneous application rate.

Other Sprinkler Systems

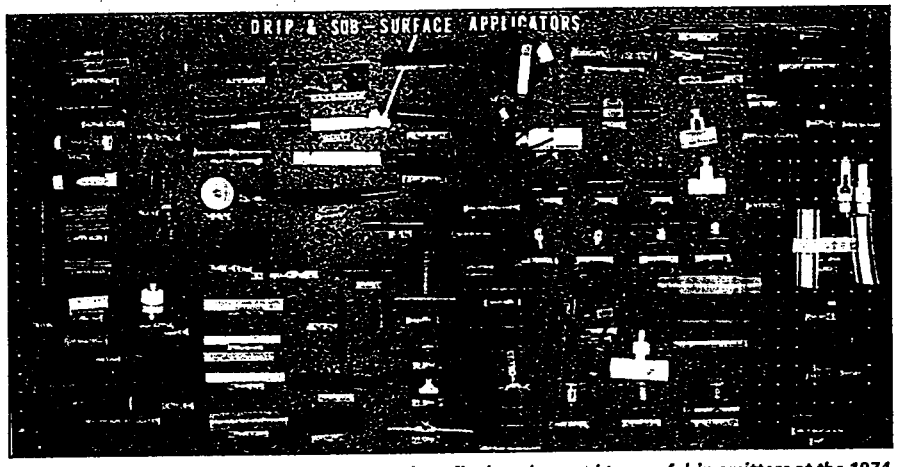
Side-roll systems were mainly adapted to shorter crops due to the limited diameter and stability of the available wheel sizes. Tri-Matic, Inc. of Brownfield, TX developed a different type of lateral moving machine that had towers 40 ft. apart and 320 ft. long sprinkler lateral drag lines behind the main line. It had a set of belts that helped the operator "steer" the machine to its next stop where it irrigated like a solid set system.

Big gun sprinklers soon evolved into travelers with drag hoses. Bart Nelson played an important role in getting the B.F. Goodrich Co. interested in manufacturing five-inch, dragable hoses. These drag hoses

were important in the soft- and hard-hose travelers that followed as well as supplying lateral-move, side-rolls, linear-move center-pivot type machines, and water driven winch machines. Various wide boom sprinklers were manufactured and are still widely used in Australia, New Zealand, and other locations that use the winch concept along with many big gun sprinklers themselves.

Microirrigation

Microirrigation, an entirely new irrigation application technology evolved in the 1960s and 1970s, although some documented concepts of it date back to 1917. As plastic materials became widely used in agriculture following World War II, an Israeli engineer working in England named Dr. Symcha Blass developed the technology to irrigate greenhouse plants. In the 1950s, he took this technology back to the Negev desert in Israel to produce crops even with highly saline waters. A San Diego County Farm Advisor in California, C. Don Gustafson, and a San Diego sprinkler manufacturer, Bruce Brown, observed Blass' work in Israel and returned to apply it to avocados in Southern California in the late 1960s. Brown formed the Drip-Eze Company. This application technology was called drip, because of the water dripped from fixed emitters, or trickle because of smaller streams from microtubes.



Sterling Davis, an early drip irrigation researcher, displayed several types of drip emitters at the 1974 Second International Drip Irrigation Congress in San Diego, CA.

The row crop, or vegetable side of drip/trickle irrigation, is often traced to Norm Smith who was working with farmers in New York with new plastic products that had become available. Later when Smith moved to Rutgers University, he began a more aggressive promotion for this technology. Soon, Dick Chapin formed Watermatics which began manufacturing small diameter plastic tubes and longer

thinned walled pipes made from thin plastic sheets. Soon bi-wall drip tubes were available that permitted longer lateral lines with acceptable flow variations along the lines. Bernarr J. Hall, another San Diego Farm advisor who worked with Gustafson, further expanded the Southern California drip/trickle work on vegetables.

In 1973, many Americans attended the first International Drip Irrigation Congress in Tel Aviv, Israel. The second congress was immediately planned for 1974 in San Diego, CA. Sterling Davis, USDA-ARS at Riverside, CA along with other colleagues in California, was instrumental in organizing this highly successful congress. Nearly 2,000 people from 29 foreign countries and the U.S. attended, and more than 70 companies exhibited equipment.

Drip/trickle irrigation was ideally suited to widely spaced plant crops like orchards or vineyards with the more traditional fixed emitters on small diameter polyethylene laterals. The drip/trickle tube products (now called tapes) were well suited to high valued vegetable crops, and even large-scale agricultural crops like sugarcane. But the heart of any successful drip/trickle system was the water filtration system. Screen filters were adapted along with media filters to reduce emitter and tape clogging from fine particles. In some cases, water treatment with chlorine and/or acids was necessary to reduce lime formation and biological clogging. Drip/trickle irrigation soon invaded the commercial, home, and garden irrigation markets together with the greenhouse industry, where Dr. Blass started his work.

The drip/trickle concept was applied to low-volume sprays by James Roberts, a San Marcos, CA citrus grower. These devices and other low-volume sprayers continued to evolve. Soon it became nearly impossible to classify all the differing types of low-volume applicators. Now, we simply "lump" all these low-volume applicators whether drip, trickle, microsprays, spitters, etc. under the single name "microirrigation."

Although overall irrigated land area has not changed substantially during the past two decades, rather dramatic changes have occurred in on-farm irrigation methods. Surface irrigation remains vitally important in U.S. agriculture, but it declined from 62% of irrigated lands in 1979 to 50% in 1998. During this time center pivots increased by 72% and microirrigation by almost 600%. Irrigation has evolved into a high-tech industry filled with people on the verge of the latest technological advances. It is without a doubt that those within the industry will continue to move it forward in the new millennium.

Dr. Terry A. Howell is Research Leader and a Supervisory Agricultural Engineer with the USDA-Agricultural Research Service (ARS) in Bushland, TX. Readers are referred to the far more detailed and complete history of irrigation found in "Water and the Land" by Robert M. Morgan. Terry can be reached by email at tahowell@ag.gov. *The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader and does not constitute an official endorsement or approval by the U.S.D.A or the ARS.*