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EC65-753 Mechanically Moved Sprinkler Systems

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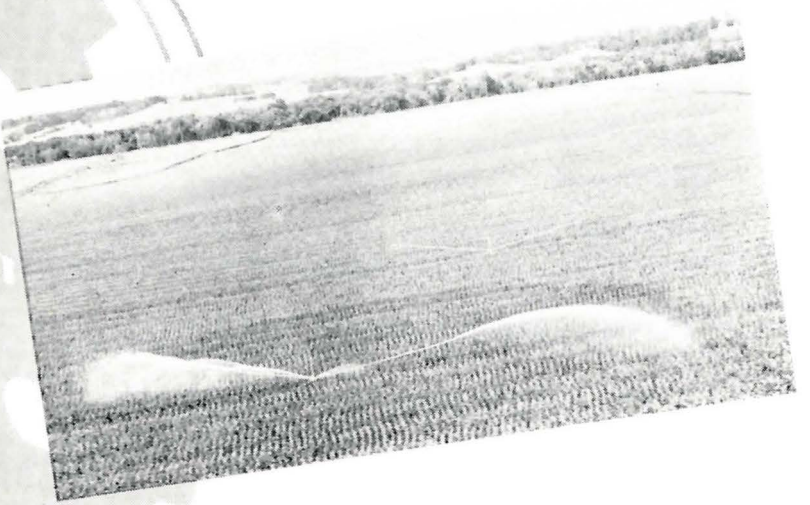
mechanically moved sprinkler systems



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University of Nebraska College of Agriculture and Home Economics
and U. S. Department of Agriculture Cooperating
E. F. Frolik, Dean J. L. Adams, Director

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SUMMARY

This publication compares mechanically moved sprinkler systems used in Nebraska.

Each system was compared at a low, medium and high water application rate where applicable. It has been assumed that the water source is located in the center of the 160-acre tract of land. Irrigation intervals are based on a consumptive daily crop use of 0.25 inches. Prices are based on what irrigators would pay for equipment in Nebraska in 1965.

This comparison includes a description of how each system operates in the field, design characteristics, operational characteristics, equipment needed to irrigate 160 acres, total and per acre investment, irrigation labor, and fuel cost per acre foot of water.

The skid-tow system appears to be best suited for all crop and soil intake rates in Nebraska. It does require special planned crop layout when irrigating tall row crops. The side-roll and skid-tow combination are equally as well suited as the skid-tow except when in tall row crops.

At the low application rate, the skid-tow and the side-roll will cover 160 acres in the designed irrigation interval. At the medium application rate the skid-tow, side-roll and side-move-tow combination will cover 160 acres in the designed irrigation interval. At the high application rate, the area covered in the irrigation interval ranges from 148 acres with the skid-tow to 122 acres with the skid giant sprinkler.

Total investment cost for a 160-acre system ranges from $24,154 for the side move-tow combination to $4,400 for the giant skid sprinkler.

Irrigation labor ranged from less than 0.10 hours per acre per irrigation with the self-propelled unit to a high of 0.66 hours with the 140-foot boom.

Fuel cost per acre foot ranged from $4.10 on the skid-tow and the side-roll at low application rates to $6.40 with skid giant at the high application rate.

Mechanically Moved Sprinkler Systems

By J. F. Decker, H. R. Mulliner[1] and J. R. Davis[2]

INTRODUCTION

Since 1946 when aluminum tubing became available at reasonable prices, sprinkler irrigation has been widely adopted throughout the world.

It has proved to be a versatile method of applying water and provides a high degree of water control in comparison to other methods of irrigation. Sprinkler systems are adaptable to most soil and topographic conditions. They are especially adapted to sandy soils with high water intake rates, to fields with steeper slopes or irregular topography, and to soils that are too shallow to grade for surface irrigation.

Water application rates with sprinklers can be as low as one-tenth inch per hour. This permits irrigation of dense soils of low permeability without soil erosion or excess water losses. Sprinkler systems generally use smaller quantities of water better than do surface irrigation methods.

Sprinkler systems are also used effectively for applying fertilizers and certain insecticides and fungicides, to stimulate germination of small seed crops, for frost protection, and for climate control when excessive heat may be a problem.

A major recent improvement in sprinkler operation is the use of smaller sprinklers over longer operating times (sets of 24 hours or longer). This method reduces pipe size and tends to improve the uniformity and efficiency of water application. Longer sets permit a better scheduling of labor and a reduction in labor requirements.

RELATIVE COSTS

Economic studies of water distribution costs by hand-move sprinklers compared with surface methods usually show considerable advantage to the latter. For example, Nebraska studies[3] showed costs of $12.95 per acre irrigated by sprinkler compared with $2.28 for irrigation by siphon tubes, a net difference of $10.67 per acre. These are costs for distributing water only. They do not include cost of pumping or land development.

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[1] District Extension Irrigationists, University of Nebraska, at St. Paul and Hastings, respectively.

[2] Chairman of the Engineering Department, University of Nebraska.

[3] Cost of Distributing Irrigation Water by Sprinkler Methods, Nebraska Station Bulletin 455, 1960 by T. S. Thorfinnson, N. P. Swanson, and A. W. Epp.

Wyoming studies[4] compared total irrigation costs for a normal year and showed $16.54 per acre irrigated from wells by sprinkler, $13.43 per acre irrigated from wells by gravity and $9.51 per acre from canal systems by gravity methods. No gated pipe was involved in gravity distribution; systems compared consisted only of farm laterals and siphon tubes.

Fuel costs and labor were cited in both studies as the principal reason for higher application cost by sprinkler.

Other studies show similar trends. Average annual costs for sprinkler systems have ranged from $15 to $25 per acre. Labor costs usually amount to about 30 percent of the total annual cost.

TRENDS TOWARD MECHANIZATION

Reducing labor costs and improving effectiveness of sprinkler irrigation requires either more pipe and equipment (for example, a permanent system) or mechanization of various components of the system. In either case, this involves a substitution of capital for labor. Mechanizing offers considerable savings in labor for very little additional capital, in contrast to permanent or solid-set systems which require a high initial investment.

As an example, studies in California showed labor requirements per acre irrigated by a lateral line 1410 feet long as follows:

Hand-move	**38 minutes per acre per irrigation**
Hand-wheel side-roll	**15 minutes per acre per irrigation**
Power-wheel side-roll	**17 minutes per acre per irrigation**
Tractor-tow	**13 minutes per acre per irrigation**

In this case, use of a tractor-tow system, which is popular in Nebraska, reduced labor costs to about one-third that of the hand-moved system.

A demonstration conducted by Mulliner in 1959 with a well designed skid-tow line sprinkler system showed a requirement of only 0.2 hours per acre per irrigation for a man and tractor.

An important factor in the use of sprinkler systems is the type of labor required and the relative difficulty of moving sprinkler pipe. Moving pipe by hand through corn, for example, is so difficult that hand-move systems for corn irrigation are almost non-existent. Since corn is an important irrigated crop in Nebraska, a mechanized system offers many advantages. The same advantages should be expected for other irrigated crops, but perhaps with different types of mechanized systems.

In view of the widespread interest in mechanically moved sprinkler systems it is our purpose to describe and summarize design and

[4] Sprinkler and Gravity Irrigation, Wyoming Experiment Station Bulletin 378, 1961, by D. M. Stevens.

operational characteristics of the various types of mechanized sprinkler systems currently available. This will give the potential irrigator an opportunity to make comparisons for his own farm conditions.

Systems whose characteristics are described include (1) skid-tow line, (2) side-roll, (3) modified side-move, (4) boom-type, (5) self propelled, (6) giant sprinkler and, (7) solid-set or sequencing systems. System requirements, investment costs, operational data, design and adaptation are summarized in Tables 1, 2, and 3.

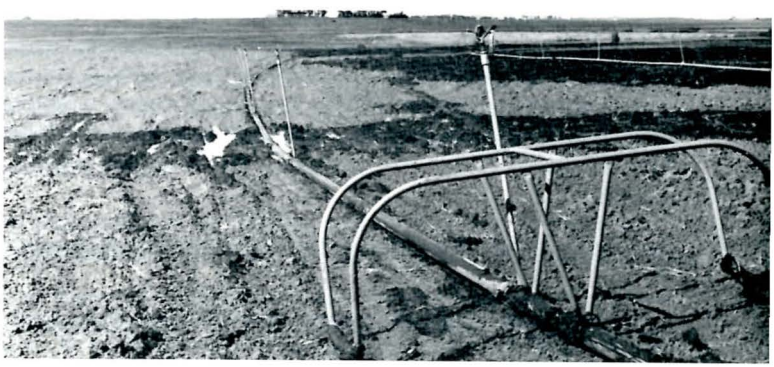
Skid-Tow Line

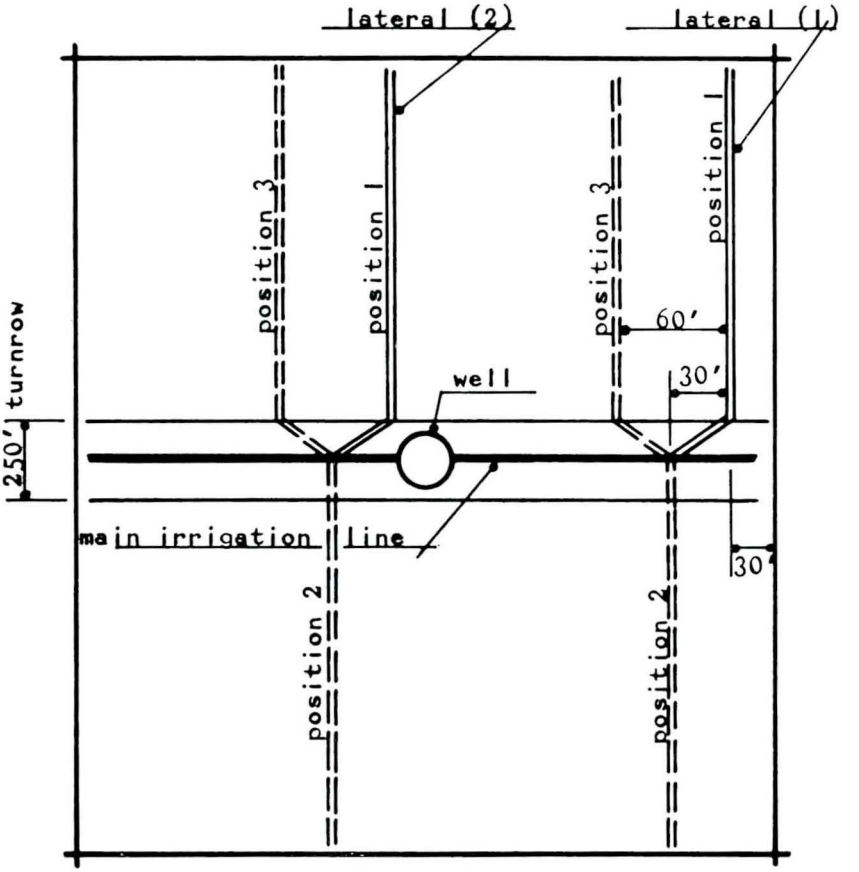
The system consists of ridgedly coupled laterals connected to a main line by flexible joint. The main line is positioned in the center of the field. Laterals are towed endways over the main line from one side of the main line to the other by tractor. Maximum length of lateral is 1,320 feet. Outriggers keep the lateral in an upright position and the skids prevent excessive pipe wear.

The system works well in grasses, legumes, and other close growing crops and nearly as well in row crops. When used in row crops, (turning area) of 200 to 250 feet in width must be allowed the whole length of the area being irrigated. This, in many cases is planted to alfalfa. Irrigating tall crops such as corn requires a crop planting arrangement, 16 rows of corn, then 4 rows of low growing row crops such as grain sorghum in which the tow line is moved. This planting arrangement is used across the entire irrigated area. The four short rows are off-set on each side of the turn area by one-half the distance between lateral positions.

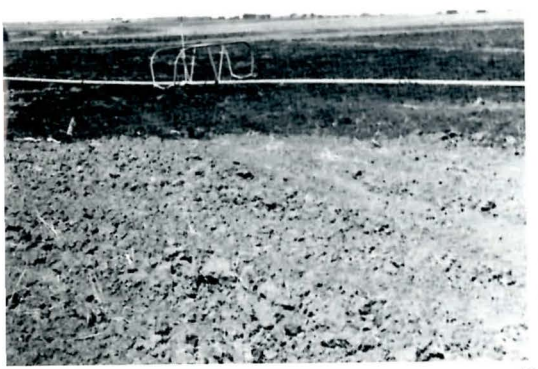
For best use of the skid-tow line the irrigable area should be square or rectangular in shape and without physical obstructions. Small irrigable areas, irregular tracts and row crops planted on the contour do not lend themselves to skid-tow line irrigation.

Sandy soils may cause excessive wear on the pipe.

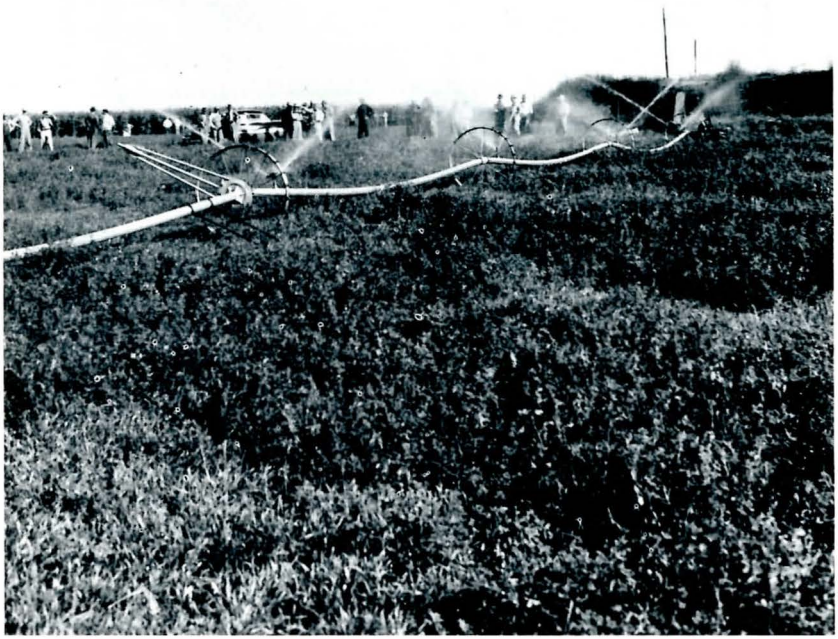




PATTERN OF SKID TOW LINE
PROGRESS THROUGH FIELD



The drawing above shows the pattern of skid-tow line across the field with four laterals. At left is a picture of the Skid-Tow Line.

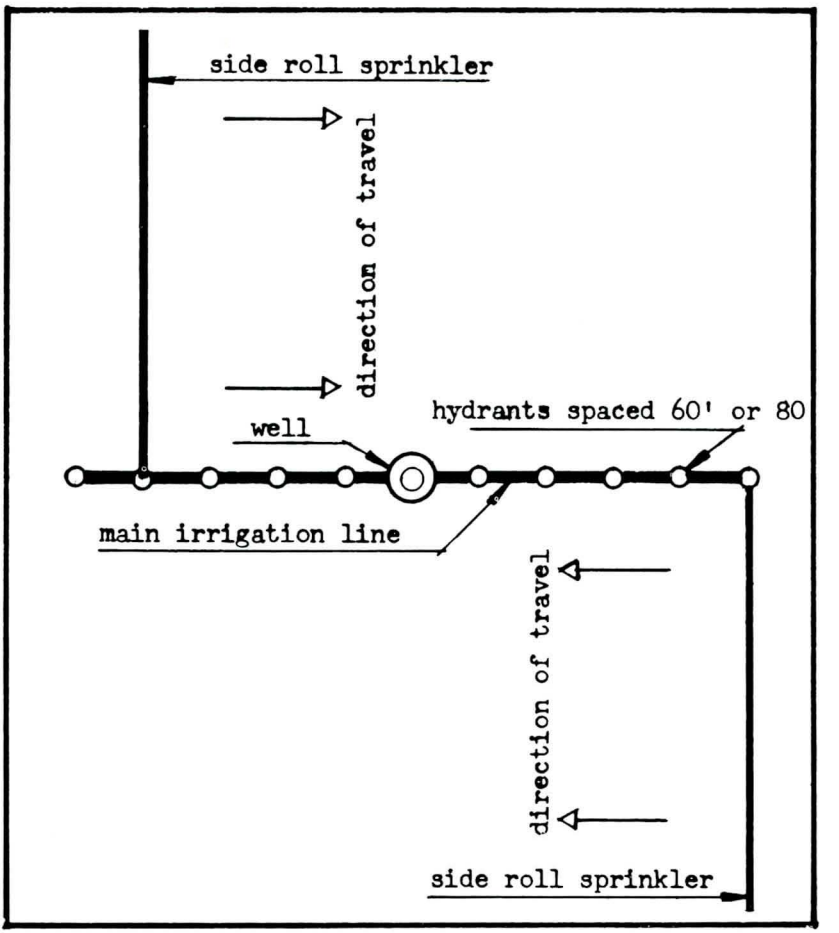


The Side-Roll Lateral System in action.

Side-Roll Lateral System

The side-roll lateral is stationary during the period of sprinkling. The lateral line is used as an axle. Five foot diameter wheels are mounted on the axle or pipe. These are spaced each 40 feet on the line. Hand or power units are used to move the lateral from one watering position to the next. Laterals are limited to 1,320 feet in length.

When the water is shut off, the pipe drains. Then the whole lateral line rolls to the next set (usually 60 feet) and the water is started again, after hooking back on to the main line.



The line drawing above shows the pattern of side-roll progress across the field.

This unit works well in close growing crops and low growing row crops. It is best adapted to rectangular fields without obstructions and with fairly uniform topography.

The problem of moving the side-roll unit laterally from one field position to another is perhaps best solved by use of continuous skid blocks mounted on a cable at 40-foot spacings upon which the unit is rolled and then pulled into the new position by tractor.

Side-Move Tow Combination

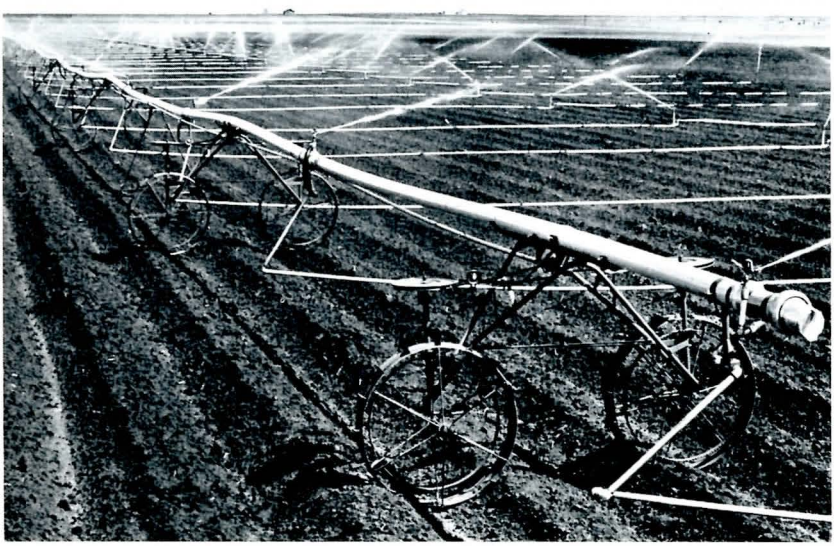
A modified side-roll system, probably best described as a side-move tow system, is new on the Nebraska market. Its physical arrangement is similar to the conventional side-roll in movement across the field. An important difference is that the sprinkler pipeline is carried above the wheels instead of serving as wheel axles like the side-roll system. The sprinkler pipeline is carried at an elevation of five feet.

The system is moved by a five horse power gasoline engine through a one-inch diameter drive shaft, V-belts and gear reductions to wheel drive units.

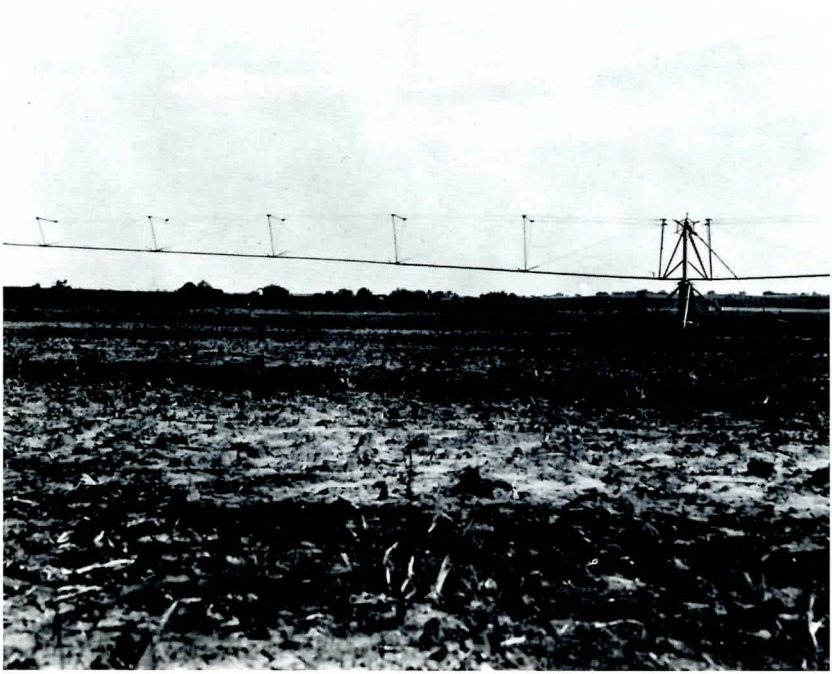
The system involves 132 sprinklers compared with the conventional 33 for a quarter mile lateral line. Sprinklers are set at 30-foot spacings along the lateral line. In addition, trailer pipe sprinklers on 50- and 100-foot spacings are towed behind the lateral line. Sprinkler pattern is 30 x 50 feet with normal discharge rates of 6.0 to 7.0 gallons per minute. The system covers an area of 4.5 acres per set and is moved 150 feet after each set.

For right angle change in direction wheels are turned parallel with the pipe line and locked and the whole system moved to another location either under its own power or by tractor.

Two modifications to the side-move tow combination are already under consideration, namely: 1. increasing sprinkler spacing to a 40 x 50 foot pattern and 2. elevating the lateral line for effective use for corn irrigation.



Side-Move Tow Combination.



Boom sprinkler.

Boom - Type

Boom-type sprinklers are mounted on a carriage which is also used for carrying sections of lateral pipe line. The lateral line is added or picked up as the sprinkler is moved progressively through the field away from or toward source of water supply as the case may be.

Commercial boom sprinklers are available in lengths of 80 to 250 feet. Capacity to apply water ranges from .75 to 4.0 acres per set, with a range in application rate of .21 to .80 inches per hour.

Boom lengths of 140 and 180 feet are the more popular sizes used in Nebraska. They are usually designed to supply water at a rate of about 0.5 inches per hour and cover 2.0 to 2.5 acres per set.

For irrigation of row crops, turning areas similar to those used for tow-line equipment perpendicular to the main line must be provided. They can be spaced 180 to 300 feet apart, however, compared with 50- to 60-feet spacing for tow-line sprinklers.

Boom sprinklers 140 and 180 feet long will distribute water over a radius of 135 and 150 feet respectively. To avoid working in muddy conditions with a tractor, the boom carriage is pulled to successive sprinkler areas by cable.

Self-Propelled sprinkler.

Self - Propelled

The self-propelled system has the unique distinction of automatic self propulsion around a central pivot through hydraulic power. Small quantities of water diverted from the pipe line at each tower are converted into 3,000 pounds of driving force delivered through hydraulic cylinders to the wheels.

The self-propelled sprinkler operates under a pressure of 75 psi at the pivot. The sprinkler system is engineered to apply water at a uniform rate throughout the length of the line by increasing nozzle size progressively from the pivot to the end of the line.

The self-propelled system will apply water at rates of less than one up to four inches per acre per go-round. Rate of application is governed by speed of rotation.

Customary length of system for a quarter section is 1,285 feet.

Self-propelled sprinklers are best adapted to sandy soils of flat to gently sloping topography. About two inches of water per acre is applied per go-round on six to eight day intervals.

Water distribution data secured by Farm Economics Research Division, ARS[5]—in 1958 shows considerable variation along one eighth mile sprinkler lines. Tests were made by measuring water in two rows of parallel cans arranged along the alleyway used as access to the pumping plant. Mean application rates ranged from 0.69 to 1.77 inches per hour.

[5] Unpublished data assembled by T. S. Thorfinnson.

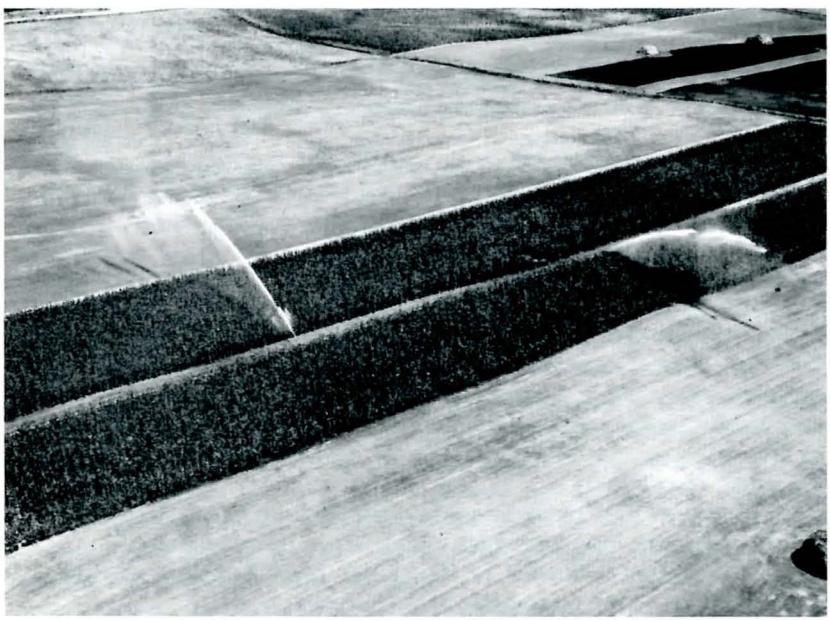
Skid Giant Sprinkler

Numerous arrangements of water distribution by use of giant sprinklers are currently on the market. Degree of automation ranges from hand-move to self-propelled giant system which represents maximum automation with large sprinklers. Self-propelled giant sprinklers together with the pto giant sprinkler depends upon a complete lateral grading job which is not much different than development for gravity irrigation.

The skid giant sprinkler may be used to distribute maximum volume of water at a minimum equipment investment cost. Capacity of these units may range from 100 up to 600 gallons per minute.

In normal use giant sprinklers may be mounted in tandem at spacings of 200 to 360 feet depending upon sprinkler capacity. The sprinklers are always positioned at the far end of the lateral line and moves are made by pulling them toward the mainline pipe. In this manner, power equipment is always kept in the dry and labor requirements minimized.

While investment costs of this type of system are very modest, adaptability is limited to sandy soil with higher intake rates and compaction problems may be experienced. This system also requires the highest operating pressure (100 pounds) of any system described in this report.



Skid Giant sprinkler

Solid Set and Sequencing Systems

Solid set and sequencing systems are semi-permanent systems with buried main lines. Lateral lines and sprinklers are left in place for the irrigation season, thus requiring no pipe moving during the crop year.

Solid set systems may be operated by rotating sprinklers, by laterals, or by sequencing sprinklers along the lateral lines. Operation can be made almost automatic by use of solenoid valve controls.

While these systems represent the ultimate in labor economy, investment requirements prevent their use except for production of very high value crops. For this reason detailed data have not been included in the comparative tables.

BASIS OF THE COMPARATIVE ANALYSIS

The various sprinkler systems described are compared on the basis of design considerations, equipment requirements for the irrigation of a quarter section farm or substantial acreage thereof, relative costs together with adaptations and limitations. For simplification the various systems are summarized in Tables 1, 2 and 3 according to low, medium and higher water application rates.

Water holding capacity of the soil and its rate of infiltration are basic considerations in sprinkler irrigation design. Soil texture is the primary factor affecting both water holding capacity and infiltration rate. While the profiles of many soils are variable the following tabulation may be of value as a guide in planning the irrigation system:

Soil texture	Available water holding capacity		Intake rate inches per hour	Sprinkler application range-inches per hour
	Inches per foot	Average profile		
Coarse sandy	.50–1.0	4.5	.80–2.0	.50–.80
Fine sandy loam	1.5–2.0	11.5	.40–.60	.35–.50
Silt loam	1.75–2.25	12.0	.20–.30	.15–.30
Clays	2.00–2.50	13.0	.08–.30	.08–.25

While it is recognized that water application rates must be fitted to the individual farm, arbitrary rates have been used in the accompanying analysis. Low rate selected was .25 inches, medium .35 inches, and high rates .50 to 1.5 inches per hour. Assuming that a moisture level of 50 percent capacity is maintained, net inches of water to apply per irrigation were 4.1, 2.89 and 2.25 for low, medium and high application rates respectively.

In analyzing design and operational characteristics of the various sprinkler systems the following assumptions were made:

1. Water supply located at the center of the quarter section.
2. Crop use rate of water—.25 inches per day.
3. Sprinkler application efficiency—75 percent.

4. Pumping plant efficiency equal to Nebraska performance standards (6.89 water horsepower hours per gallon of propane).

5. An assumed lift of 100 feet at the well is added to pressure at the pump to determine total head.

All systems have been designed to meet engineering standards of not more than 20 percent pressure loss along lateral lines.

In the section of relative costs total investment and annual ownership costs are shown for each system and on an acre basis. Annual ownership was determined on 15 year depreciation and 5½ percent interest. Annual ownership cost per acre applies to the acreage of the system capacity.

No attempt was made to summarize total operating costs. Only the fuel cost per acre foot of water pumped was determined. This was based on 10-cent-per-gallon propane at the efficiency level assumed above.

COMPARISON OF MECHANICALLY MOVED SPRINKLER SYSTEMS

The three sprinkler systems summarized in Table 1 are suited to water applications at lower rates. The skid-tow line and side-roll sprinklers may be used effectively over a wide range of application rates. The side-move tow combination is included only in low and medium rates of application. Friction losses exceed engineering design of 20 percent for higher application rates in the six inch sprinkler lines which are currently available.

Likewise, boom sprinklers have not been included in low application rates since maximum capacity per sprinkler unit is an important sales factor.

Labor requirement, investment, fuel cost per acre foot of water pumped, and system adaptability are basic comparisons. Labor requirements include time for moving the sprinklers through the field and positioning them for subsequent use. Sprinkler investment costs are shown for a quarter section system and investment costs per acre of system capacity. Annual investment costs are based upon normal depreciation rates and five and one half percent interest. Costs per acre again reflect system capacity.

An assumed lift of 100 feet for water pumped, discharge pressure at the pump, and pumping rate determine water horsepower. Water horsepower multiplied by hours pumping per acre foot equals water horsepower hours per acre foot. Fuel cost per acre foot is determined by multiplying water horsepower hours per acre foot by cost per unit of fuel and dividing by the Nebraska Performance Standard of water horsepower hours per unit of fuel.

As shown in Table 1, labor requirements were the same for the skid-tow line and side-roll systems. The new side-move-tow combination

Table 1.—Characteristics of mechanically moved sprinkler systems—low application rates.

I. Design considerations	Skid-Tow	Side-Roll	Side-Move tow combination
1—Water application rate, inches per hr.	0.25	0.25	0.25
2—Net depth of water to be applied, inches (75% eff.)	4.1	4.1	4.1
3—Irrigation interval @ ¼"/day	16	16	16
II. Equipment requirements per 160 acres			
1—Length of main line in ft., diameter in inches	840'-8", 1740'-6"	840'-8", 1740'-6"	2580'-8"
2—Length of each sprinkler line in ft., diameter in inches	1280'-4"	1280'-4"	1290'-6"
3—Number of sprinkler lines	6	6	2
4—Number of sprinklers per line	33	33	132
III. Operational characteristics			
1—Gallons per minute per sprinkler line	205	205	515
2—Total water requirement, gpm	1230	1230	1030
3—Spacing between sprinkler lines, ft.	60	60	150
4—Area covered per sprinkler line, acres	1.82	1.82	4.5
5—Sets required	15—4 lines, 14—2 lines	15—4 lines, 14—2 lines	16
6—Total sets for all sprinkler lines	88	88	32
7—Irrigation time per set, hrs.	22	22	22
8—Moving time per sprinkler line, hrs.	0.3	0.3	0.5
9—Total labor per irrigation, hrs.	30.4	30.4	22
10—Labor per acre per irrigation, hrs.	.19	.19	.15
11—Operating pressure at pump, psi	47	47	55
12—Days to complete full irrigation on 160 acres	15	15	18
13—Acres irrigated by system in irrigation interval	160	160	144
IV. Relative cost conditions			
1—Sprinkler system investment, dollars	$12,710.00	$22,543.00	$24,154.00
2—Investment cost per acre irrigated, dollars per acre	79.50	141.50	167.74
3—Annual fixed cost for sprinkler, dollars per year	1,197.00	2,123.00	2,275.31
4—Annual fixed cost per acre, dollars per year, per acre	7.50	13.30	15.81
5—Whp-hrs., per acre ft	285	285	307
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$4.10	$4.10	$4.46
V. Adaptions and limitations			
1—Soils	All soils	All soils	All soils
2—Crops	All crops	All except tall crops	All except tall crops
3—Special suitability	Planned layout for row crops	Not suited to corn, milo or orchards	Not suited to corn, or orchards
4—Special limitations			

labor requirement was just slightly less. Investment costs are about 77 percent higher for the side-roll and 90 percent higher for the side-move-tow combination than with the skid-tow line. On the per acre basis, costs of the side-move-tow combination are double those of the skid-tow line.

Fuel costs per acre foot of water pumped were equal for the skid-tow line and side-roll systems and 36 cents per acre foot greater for the side-move-tow combination due to a higher operating pressure.

Each of the systems are suitable to all soil classes. A planned layout is necessary for the skid-tow line system in row crops. Use of side-roll and side-move-tow combination is limited to low growing crops.

Relative labor requirements for water application at rates of .35 inches per hour, Table 2, are similar to those reported for lower application rates for skid-tow line, side-roll and side-move-tow combination systems. Labor required per acre for the 80 foot boom system was over three times that recorded for these systems.

Investment costs for the skid-tow line are slightly reduced when designed for medium application compared with the same system designed for low application rates due to a reduction of lateral lines from six to four. Lateral size has been increased from four to five inches in diameter.

A reduction of $4,777 is shown in the investment cost of the side-roll system designed for a medium rate of application compared with low rate. This is a saving of 27 percent. Since similar equipment is used by the side-move-tow combination investment costs would be the same as that reported for the low rate application. The 80 foot boom showed the smallest investment requirement of any in the medium application rate group.

Fuel costs per acre foot of water pumped are equal for the skid-tow line and the side-roll systems, 20 cents higher for the side-move-tow combination and 69 cents higher for the 80 foot boom. The discharge pressure of 75 psi for the boom system has increased water horsepower per acre foot of water pumped to 387 compared to 304 for skid-tow line and side-roll systems and 317 for the side-move-tow combination system.

Similar adaptability characteristics apply to the first three systems as were reported under conditions of lower application rates. The 80 foot boom requires a planned layout for row crops similar to the skid-tow line excepting for 240 foot spacings instead of 60 feet. It is also adapted to irrigation of all crops.

Of the sprinkler systems compared under higher application rates, Table 3, minimum labor per acre irrigated occurs with the self-propelled system under sandy land conditions where it is most adapted. Labor requirements for the skid giant sprinkler system was slightly lower than for skid-tow line or side-roll systems. Labor for these systems

Table 2.—Characteristics of mechanically moved sprinkler systems—medium application rates.

I. Design considerations	Skid-Tow	Side-Roll
1—Water application rate, inches per hr.	0.35	0.35
2—Net depth of water to be applied, inches (75% eff.)	2.89	2.89
3—Irrigation interval @ ¼"/day	11.5	11.5
II. Equipment requirements per 160 acres		
1—Length of main line in ft., diameter in inches	1260'-8", 1320'-6"	1260'-8", 1320'-6"
2—Length of each sprinkler line in ft., diameter in inches	1280'-5"	1280'-5"
3—Number of sprinkler lines	4	4
4—Number of sprinklers per line	33	33
III. Operational characteristics		
1—Gallons per minute per sprinkler line	288	288
2—Total water requirement, gpm	1152	1152
3—Spacing between sprinkler lines, ft.	60	60
4—Area covered per sprinkler line, acres	1.82	1.82
5—Sets required	22	22
6—Total sets for all sprinkler lines	33	33
7—Irrigation time per set, hrs.	11	11
8—Moving time per sprinkler line, hrs.	0.3	0.3
9—Total labor per irrigation, hrs.	30.4	30.4
10—Labor per acre per irrigation, hrs.	.19	.19
11—Operating pressure at pump, psi	53	53
12—Days to complete full irrigation on 160 acres	11	11
13—Acres irrigated by system in irrigation interval	60	160
IV. Relative cost conditions		
1—Sprinkler system investment, dollars	$11,775.00	$17,766.00
2—Investment cost per acre irrigated, dollars per acre	73.54	111.04
3—Annual fixed cost for sprinkler, dollars per year	1,108.00	1,674.00
4—Annual fixed cost per acre, dollars per year, per acre	6.90	10.50
5—Whp—hrs. per acre ft.	304	304
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$4.41	$4.41
V. Adaptions and limitations		
1—Soils	Medium soils	Medium soils
2—Crops	All crops	All except tall crops
3—Special suitability		
4—Special limitations	Planned layout for row crops	Not suited to corn, milo or orchards

Table 2.—Characteristics of mechanically moved sprinkler systems—medium application rates (continued).

I. Design considerations	Side-Move tow combination	80 foot boom
1—Water application rate, inches per hr.	.35	.35
2—Net depth of water to be applied, inches (75% eff.)	2.89	2.89
3—Irrigation interval @ ¼"/day	11.5	11.5
II. Equipment requirements per 160 acres		
1—Length of main line in ft., diameter in inches	2580'-8"	240'-6", 1920'-5"
2—Length of each sprinkler line in ft., diameter in inches	1290'-6"	1200'-5"
3—Number of sprinkler lines	2	5
4—Number of sprinklers per line	132	1 boom
III. Operational characteristics		
1—Gallons per minute per sprinkler line	721	210
2—Total water requirement, gpm	1442	1050
3—Spacing between sprinkler lines, ft.	150	240
4—Area covered per sprinkler line, acres	4.5	1.3
5—Sets required	18	22
6—Total sets for all sprinkler lines	36	110
7—Irrigation time per set, hrs.	11.0	11.0
8—Moving time per sprinkler line, hrs.	.50	.50
9—Total labor per irrigation, hrs.	21.0	95
10—Labor per acre per irrigation, hrs.	.13	.65
11—Operating pressure at pump, psi	57	75
12—Days to complete full irrigation on 160 acres	9	13
13—Acres irrigated by system in irrigation interval	160	146
IV. Relative cost conditions		
1—Sprinkler system investment, dollars	$24,154.00	$10,180.00
2—Investment cost per acre irrigated, dollars per acre	150.96	69.67
3—Annual fixed cost for sprinkler, dollars per year	2,275.31	958.95
4—Annual fixed cost per acre, dollars per year, per acre	14.22	6.59
5—Whp—hrs. per acre ft.	317	387
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$4.60	$5.10
V. Adaptions and limitations		
1—Soils	Sandy loam	Medium soils
2—Crops	Close growing, low row crops	All crops
3—Special suitability		Tall crops
4—Special limitations	Not suited for corn or orchard	Planned layout for row

remains under .20 hours per acre per irrigation similarly to their use under low and medium application rates. Here again labor for boom systems averages about three times the rate of skid-tow line and side-roll systems.

Investment costs of the skid giant sprinkler system are very low compared with other systems considered in Table 3. Investment requirements for sprinkler systems suited to high application rates are about the same as for the skid-tow line and the boom systems. Cost of the side-roll and self-propelled systems average 42 to 45 percent greater.

Fuel cost per acre foot of water pumped for skid-tow and side-roll are equal at $4.37. Boom and self-propelled systems average about $1 per acre foot higher due to the higher operating pressures required. Highest fuel cost is shown for the skid giant system at $6.40 per acre foot. This reflects the higher operating pressure compared with other systems.

All systems included in Table 3 are limited in adaptability to sandy land with relatively high intake rates. Planned layouts for row crops are required for the skid-tow line, the two boom systems and the skid giant sprinkler. The side-roll is not suited to tall crops.

Table 3.—Characteristics of mechanically moved sprinkler systems—higher application rates.

I. Design considerations	Skid-Tow	Side-Roll
1—Water application rate, inches per hr.	0.5	0.5
2—Net depth of water to be applied, inches (75% eff.)	2.25	2.25
3—Irrigation interval @ ¼"/day	9	9
II. Equipment requirements per 160 acres		
1—Length of main line in ft., diameter in inches	2580'-8"	2580'-8"
2—Length of each sprinkler line in ft., diameter in inches	1280'-5"	1280'-5"
3—Number of sprinkler lines	3	3
4—Number of sprinklers per line	33	33
III. Operational characteristics		
1—Gallons per minute per sprinkler line	413	413
2—Total water requirement, gpm	1238	1238
3—Spacing between sprinkler lines, ft.	60	60
4—Area covered per sprinkler line, acres	1.82	1.82
5—Sets required	27	27
6—Total sets for all sprinkler lines	81	81
7—Irrigation time per set, hrs.	6	6
8—Moving time per sprinkler line, hrs.	0.3	0.3
9—Total labor per irrigation, hrs.	30.4	30.4
10—Labor per acre per irrigation, hrs.	.19	.19
11—Operating pressure at pump, psi	52	52
12—Days to complete full irrigation on 160 acres	10	10
13—Acres irrigated by system in irrigation interval	148	148
IV. Relative cost conditions		
1—Sprinkler system investment, dollars	$10,012	$14,512
2—Investment cost per acre irrigated, dollars per acre	67.60	98.00
3—Annual fixed cost for sprinkler, dollars per year	943	1,367
4—Annual fixed cost per acre, dollars per year, per acre	6.40	9.20
5—Whp—hrs. per acre ft.	300	300
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$4.37	$4.37
V. Adaptions and limitations		
1—Soils	Sandy soils	Sandy soils
2—Crops	All crops	Low growing crops
3—Special suitability		
4—Special limitations	Planned layout for row crops	Not suited to corn, milo or orchards

Table 3.—Characteristics of mechanically moved sprinkler systems—higher application rates (continued).

I. Design considerations	140′ Boom	180′ Boom
1—Water application rate, inches per hr.	0.50	0.62
2—Net depth of water to be applied, inches (75% eff.)	2.25	2.25
3—Irrigation interval @ ¼″/day	9	9
II. Equipment requirements per 160 acres		
1—Length of main line in ft., diameter in inches	2160′-5″	540′-8″ + 1620′-6″
2—Length of each sprinkler line in ft., diameter in inches	1200′-5″	1170′-6″
3—Number of sprinkler lines	4	3
4—Number of sprinklers per line	1 boom	1 boom
III. Operational characteristics		
1—Gallons per minute per sprinkler line	295	468
2—Total water requirement, gpm	1180	1404
3—Spacing between sprinkler lines, ft.	240	270
4—Area covered per sprinkler line, acres	1.3	1.67
5—Sets required	27	27
6—Total sets for all sprinkler lines	108	81
7—Irrigation time per set, hrs.	6	5
8—Moving time per sprinkler line, hrs.	0.5	0.5
9—Total labor per irrigation, hrs.	94	76.5
10—Labor per acre per irrigation, hrs.	.66	.56
11—Operating pressure at pump, psi	77.8	75.0
12—Days to complete full irrigation on 160 acres	10	10.6
13—Acres irrigated by system in irrigation interval	143	136
IV. Relative cost conditions		
1—Sprinkler system investment, dollars	$10,820	$10,932
2—Investment cost per acre irrigated, dollars per acre	75.79	80.38
3—Annual fixed cost for sprinkler, dollars per year	1019.24	1029.79
4—Annual fixed cost per acre, dollars per year, per acre	7.13	7.57
5—Whp—hrs. per acre ft.	383	358
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$5.56	$5.10
V. Adaptions and limitations		
1—Soils	Sandy soils	Sandy soils
2—Crops	All crops	All crops
3—Special suitability	Tall crops	Tall crops
4—Special limitations	Planned layout for row crops	Planned layout for row crops

Table 3.—Characteristics of mechanically moved sprinkler systems—higher application rates (continued).

I. Design considerations	Self-Propelled	Skid Giant Sprinkler
1—Water application rate, inches per hr.	1.5	.62
2—Net depth of water to be applied, inches (75% eff.)	2.25	2.25
3—Irrigation interval @ ¼"/day	9	9
II. Equipment requirements per 160 acres		
1—Length of main line in ft., diameter in inches		1200'-8"
2—Length of each sprinkler line in ft., diameter in inches	1285'-6"	1200'-8"
3—Number of sprinkler lines	1	1
4—Number of sprinklers per line	41	2
III. Operational characteristics		
1—Gallons per minute per sprinkler line	900	480
2—Total water requirement, gpm	900	960
3—Spacing between sprinkler lines, ft.		340-(2' on line)
4—Area covered per sprinkler line, acres		1.7 x 2-3.4
5—Sets required	1	36
6—Total sets for all sprinkler lines	1	36
7—Irrigation time per set, hrs.	207	5
8—Moving time per sprinkler line, hrs.		0.5
9—Total labor per irrigation, hrs.	9.0	20
10—Labor per acre per irrigation, hrs.	.065	.16
11—Operating pressure at pump, psi	75	98
12—Days to complete full irrigation on 160 acres	8.6	12
13—Acres irrigated by system in irrigation interval	138	122
IV. Relative cost conditions		
1—Sprinkler system investment, dollars	$15,467.50	$4400
2—Investment cost per acre irrigated, dollars per acre	112.08	36.07
3—Annual fixed cost for sprinkler, dollars per year	1,457.04	487.52
4—Annual fixed cost per acre, dollars per year, per acre	10.56	3.91
5—Whp—hrs. per acre ft.	373	422
6—Fuel cost per acre ft. with propane @ 10¢ per gal., dollars	$5.41	$6.40
V. Adaptions and limitations		
1—Soils	Sandy soils	Sandy soils
2—Crops	All crops but orchards	All crops
3—Special suitability	Labor saver in adapted soils	
4—Special limitations	Not suited to slopes over 5%	Planned layout for row crops