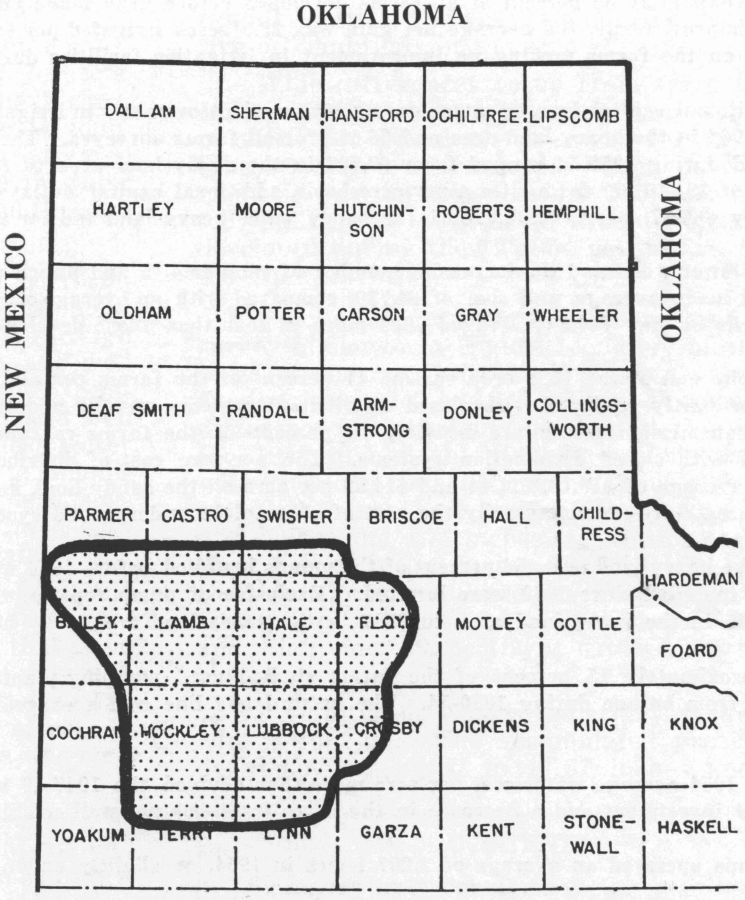
Bulletin 828 March 1956

• Changes in Investment and
• Irrigation Water Costs,
• Texas High Plains, 1950 - 54



The principal irrigated cotton production area of the High Plains is the shaded portion of the map.

in cooperation with the
UNITED STATES DEPARTMENT OF AGRICULTURE

TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

SUMMARY AND CONCLUSIONS

Substantial changes have occurred in conditions affecting irrigated farming on the Texas High Plains during the drouth and near-drouth conditions of 1950-54. The number of irrigated farms, wells, acres irrigated and the amount of water used, both total and per acre, have increased materially. The number of acres irrigated per farm in 1954 was up 11 percent from 1949; however, it declined 4 percent from 1953 to 1954. The acreage irrigated per well was down 26 percent from 1949, with almost a third of it occurring between the 1953 and 1954 crop year. Water levels declined an average of 18 feet during 1950-54. Pumping lifts increased 16 percent and well yields declined about 18 percent between 1938 and 1951. Expanded development and heavier pumping accelerated these trends.

In the surveyed area, one or more wells were added on 55 percent of the old farms; approximately 40 percent of the old farms installed underground concrete tile or surface pipe distribution systems and 49 percent lowered pumps. A higher proportion of old sandy-land farms added wells and distribution systems, and a higher proportion of old heavy-land farms have lowered pumps.

Approximately 9 percent of the irrigated farms developed since 1950 installed additional wells and 24 percent of the pumps on these farms were lowered.

Approximately 85 percent of all farms developed before 1950 made one or more of these improvements. On farms making improvements, the average net gain was 28.9 acres irrigated per farm. An average net gain of 3 irrigated acres occurred on the farms making no improvement in irrigation facilities during 1950-54.

Additional capital investment on farms making improvements in irrigation facilities averaged $7,600 in the sandy-land area, $5,664 in the heavy-land area and $6,642 for all farms surveyed. The average cost of irrigation facilities on farms developed during 1950-54 ranged from $7,702 in the sandy-land area to $11,450 in the heavy-land area, with an area average of $9,810 per farm. On a per-acre basis, additional capital outlays increased the per-acre investment on old farms by $36.27, $19.15 and $25.25 for sandy land, heavy land and for the area, respectively.

Shallower wells and the increasing number of smaller 4, 5 and 6-inch pump installations in the sandy-land area are reflected in an average well cost of $4,730, compared with an average of $6,112 per well in the heavy-land area. For the area, wells on new farms averaged $800 more in cost than those developed during the same period on old farms.

By the end of the 1954 crop season, 41 percent of the farms containing 45 percent of the irrigated acreage were wholly or partly equipped with closed distribution systems, usually underground concrete tile. On the sandy-land area, where transmission losses are heavier, 46 percent of the farms containing 54 percent of the irrigated acreage were equipped with closed distribution systems. The per-acre cost of distribution systems ranged from 86 cents to $84.83 with an average of $19.18, $11.44 and $14.96 per acre on the sandy land, heavy land and for the area, respectively. These average costs are not necessarily the cost of a complete underground system.

In the heavy-land area, 54 percent of the pumps installed before 1950 were lowered one or more times and 30 percent of those installed since 1950 were lowered. Exclusive of pump repairs, the average cost of lowering a pump ranged from $445 in the heavy-land area to $587 in the sandy-land area.

Approximately 15 percent of the farms studied used pumping plants fueled with natural gas. Most of these had changed from butane during 1950-54. The natural gas line cost averaged $1,864 per farm, or slightly under $1,000 per well.

The 1954 average water cost per acre more than doubled the 1947-49 average. Increased hours of pump operation, increased investment and a decrease in the acres irrigated per well combined to raise water costs.

Pumps operated an average of 2,207 hours in 1954, or slightly under 2.5 times longer than the 1947-49 average.

The per-acre cost of water increases sharply as the acreage irrigated per well drops below 71 to 90 acres. The 1950-54 decrease of 26 percent in acres irrigated per well suggests that a continued increase in water costs can be expected, particularly in the sandy-land area where the decrease has been heaviest.

Irrigated crop yields in 1954 were the highest on record. Because the weather in 1954 was particularly favorable for irrigated cotton, subsequent crop-yield data will be required to determine whether the increase in yield reflects the effects of improved practices and increasing irrigation skills or only 1954 weather conditions.

Results of this study suggest that future efforts should be centered on water conservation, possibly including a shift to less intensive water-use practices. The problem of allocating these diminishing resources through time is complicated by the farm debt structure, increased land values, increasing production costs, declining farm prices and prospective reduction in cotton acreage. This study also indicates the need for a re-examination of overall farm irrigation costs with emphasis on the "break-even" point under modified water-use practices at present and future price levels.

Changes in Investment and Irrigation Water Costs, Texas High Plains, 1950 - 54

WILLIAM F. HUGHES and A. C. MAGEE*

IRRIGATION DEVELOPMENT ON THE HIGH PLAINS expanded rapidly during the drouth and near-drouth conditions of 1950-54. During this period, the number of irrigation wells increased from 14,000 to 27,500 and irrigated acreage increased from 1,860,000 to 3,500,000. Ground water withdrawals also rose sharply from 1,600,000 acre-feet in 1950 to 5,200,000 acre-feet in 1954.[1/2]

This rapid and substantial expansion has affected the overall situation in several respects. Expanded development and water use have caused a decline in regional water levels. In 11 counties where more than 80 percent of the irrigated acreage is located, the regional decline in water level was approximately 18 feet from 1950 through 1954.[3]

Changes in pumping lift and well performance are other effects of expanded development and increased water use. From 1938 through 1951, pumping lifts increased 16 percent and well yields declined approximately 18 percent.[4] Similar information regarding pumping lift and well performance during the years of heaviest water use is not available. The growing shift to smaller pumps, together with reports from farmers, suggest that well performance has deteriorated considerably in some parts of the High Plains.

An additional effect, not touched on in the work previously cited, results from the changes in both investment and operating costs that have been required to keep abreast of the changing water supply situation. A farm survey designed to ascertain these changes and their effect on acres irrigated and farm operating costs was conducted in June 1955.

The survey covered the irrigated portions of Lynn, Terry, Crosby, Lubbock, Hockley, Bailey, Lamb, Hale and Floyd counties and the southern third of Swisher, Castro and Parmer counties. Conditions in this area are comparable with those covered by farm management studies conducted in 1947, 1948 and 1949.[5] For comparison with the earlier findings, the counties covered in the 1955 survey are grouped according to predominant soil textures. Data for Lubbock, Hockley, Lamb, Bailey and the surveyed portion of Parmer county are designated "sandy land"; those for Crosby, Floyd, Hale, Swisher and Castro counties are designated "heavy land." Data for Lynn and Terry counties are reported separately without comparison.

This bulletin presents the results of this survey. The data and comparisons pertain to the surveyed farms. These farms were selected at random so that the results would be representative of conditions in the area surveyed.

Wide differences occur from farm to farm for most of the items included in the survey. Comparisons are based on averages for the items, types or measures involved. Farms on which irrigation was developed before 1950 are designated "old farms." Farms on which irrigation was developed during the 1950-54 period are designated "new farms."

Precipitation during the time covered by this survey is shown in Figure 1. Many of the comparisons contrast 1954 conditions with those that existed from 1947 to 1949. There is considerable difference in the amount of precipitation between the 1947-49 and the 1950-54 periods compared with the long-time average. There was an accumulated excess of precipitation amounting to 3.72 inches and 6.74 inches at Lubbock and Plainview, respectively, during 1947-49. In contrast, there was an accumulated precipitation deficiency amounting to 23.24 and 17.32 inches at Lubbock and Plainview, respectively, from 1950 through 1954.

Precipitation was considerably below average in 1952-54. The accumulated precipitation deficiency amounted to 17.61 inches and 18.01

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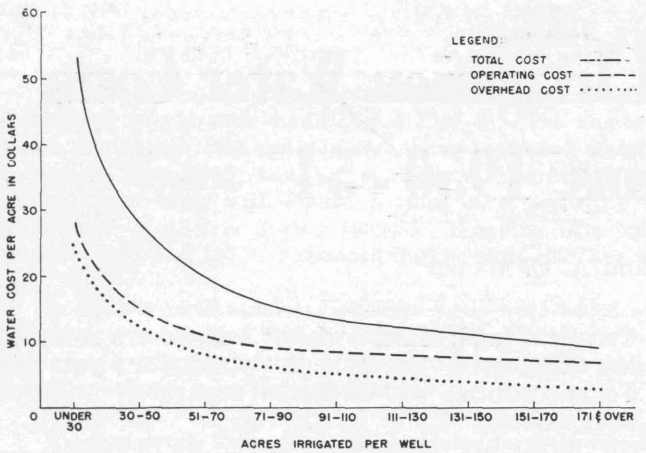

Figure 1. Water cost per acre related to acres irrigated per well.

inches, respectively, at Lubbock and Plainview during this period.

OVERALL CHANGES

Many changes in the amount and type of irrigation facilities occurred from 1950 through 1954. There were no changes in irrigation facilities or equipment during 1950-54 on 15 percent of the surveyed farms, but irrigation costs increased substantially, primarily because of the increased hours of pump operation required during the drouth years (Figure 1.) On 85 percent of the surveyed farms, the installation of additional wells and underground distribution systems, the lowering of pumps and the increased hours of pump operation caused a material rise in the per-acre cost of irrigation. On some farms the operator was not able to maintain his 1949 scale of operation. On other farms, relatively minor capital outlay permitted an expansion of irrigated acreage. The net overall changes from improvements in 1950-54 are shown in Table 1.

The number of irrigated farms increased 20 percent during 1950-54, mostly in the heavy-land areas (Table 1). During the drouth and near-drouth conditions of 1950-54, water use increased from 0.86 acre-feet to 1.48 acre-feet per acre irrigated.[1/2] Well numbers increased approximately 20 percent and hours of pump operation increased 135 percent. Both were required to meet the increased water demand, which suggests that well yields have dropped sharply.

Table 1. Relative change in numbers of irrigated farms, wells, acres irrigated per farm, acres irrigated per well and hours of operation per well, Texas High Plains, 1950-54

Item	Percentage of 1949 (1949 = 100)					
	Sandy land		Heavy land		Area surveyed[1]	
	1953	1954	1953	1954	1953	1954
Irrigated farms (No.)	128	128	125	131	126	129
Irrigation wells (No.)	184	197	170	193	176	195
Irrigated acres, per farm	110	105	118	116	115	111
Irrigated acres, per well	71	62	93	84	82	74
Hours of operation per well[2]	[3]	239	[3]	220	[3]	235

[1]Exclusive of Lynn and Terry counties.
[2]Average hours of pump operation 1947-49 = 100.
[3]Data not available.

Table 2. Type of improvement and proportion of all pre-1950 irrigated farms making improvements during the 1950-54 period, Texas High Plains

Type of improvement	Percentage of all pre-1950 irrigated farms		
	Sandy land	Heavy land	Area[1]
Installation of additional wells	61.6	48.9	55.0
Installation of distribution systems[2]	46.5	33.7	39.8
Lowering of pumps	31.3	65.2	48.9
Installation of natural gas lines	9.3	19.5	14.6

[1]Exclusive of Lynn and Terry counties.
[2]Underground concrete tile or portable aluminum surface pipe.

TYPE AND EXTENT OF IMPROVEMENTS

The type, extent and combination of improvements differ from farm to farm, depending on conditions on the particular farm and the methods used to maintain or improve farm water supplies. These improvements include: (1) installation of additional wells, (2) installation of underground distribution systems, (3) lowering of pumps and (4) installation of natural gas lines. The first three bear directly on the provision or maintenance of water supplies; the fourth is more important in connection with operating costs (Table 2).

The data in Table 2 are not additive, as two or more improvements usually are installed on the same farm. In the sandy-land area, water-bearing formations usually are thinner than the formations that underlie a large part of the heavy-land area and a higher proportion of pumps originally were set at or near the bottom of the formation. Under these conditions, it was necessary to drill additional wells to maintain or improve farm water supplies. In the heavy-land area, with unexploited water resources, farm water supplies have been maintained or supplemented to some extent by lowering pumps—a less expensive operation than drilling a new well.

The higher proportion of farms with underground concrete tile or portable aluminum surface pipe distribution systems in the sandy-land area reflects an attempt to minimize ditch losses which are much higher in this area than in the heavy-land area.[6]

The proportion of farms making improvements and the combination of improvements by farms are shown in Table 3.

Table 3. Type and extent of improvements on irrigated farms developed before 1950, Texas High Plains, 1950-54

Type of improvement	Percentage of all pre-1950 irrigated farms[1]		
	Sandy land	Heavy land	Area[1]
Farms with no capital improvements since 1949[3]	17.4	13.1	15.2
Farms making capital improvements, 1950-54	82.6	86.9	84.8
Additional wells only	19.9	11.9	15.7
Distribution systems only[4]	8.1	2.2	5.0
Wells and distribution systems[4]	23.3	7.6	15.2
Lowering pumps only	8.1	21.7	15.2
Lowering pumps + additional wells	8.1	19.5	14.0
Lowering pumps + distribution systems[4]	4.6	14.2	9.5
Lowering pumps + additional wells and distribution systems[4]	10.5	9.8	10.2

[1]Number of irrigated farms in sample, 177 (sandy-land area, 86; heavy-land area, 91).
[2]Exclusive of Lynn and Terry counties.
[3]Exclusive of natural gas lines.
[4]Sprinkler systems not included.

Table 4. Change in acreage irrigated and in type of improvements between 1949 and 1954 on farms where irrigation was developed before 1950

Type of improvement	No. of farms	Av. acres irrigated per farm, 1954	Av. change in acres irrigated per farm[1]	
			Net gain, acres	Net loss, acres
Farms with no capital improvement since 1949[2]	18	154.2	3.0	
Farms making capital improvements since 1949[2]	99	253.0	28.9	
Additional wells only	14	224.8	18.1	
Distribution systems only[3]	7	201.7		27.3
Distribution systems + additional wells[3]	15	200.8	19.3	
Lowering pumps only	22	202.4		4.5
Lowering pumps + additional wells	13	362.2	105.9	
Lowering pumps + distribution systems[3]	10	254.0	.6	
Lowering pumps + additional wells and distribution systems[3]	18	321.1	68.4	

[1]Exclusive of Lynn and Terry counties.
[2]Exclusive of natural gas line installation.
[3]Sprinkler systems not included.

Improvements involving the installation of additional wells contribute to increased irrigated acreage (Table 4). Neither the installation of an underground or surface pipe distribution system nor the lowering of pumps alone enabled a farm operator to maintain the acreage irrigated in 1949. Installing a distribution system and lowering pumps provided sufficient water to maintain the acreage irrigated. All the substantial gain in irrigated acreage shown for lowering pumps plus additional wells was realized in the heavy-land area. Lowering pumps and adding wells did not maintain the acreage irrigated on sandy-land farms. The irrigated acreage on these farms averaged 20 acres less in 1954 than in 1950.

Farms on which improvements were made during this period were almost 100 acres larger than those making no improvement. The farm-size data are incomplete; however, several of the farms in the "no improvement" category are relatively small 80 to 160-acre tracts. Possibly these farms were not improved in 1950-54 because the 1949 farm water supplies were more than adequate for the acreage irrigated and subsequent changes in the water supply have not reduced it beyond the 1954 acreage needs.

Tables 2, 3 and 4 relate to irrigated farms developed before the 1950 crop year. Similar improvements were made on farms where irrigation was developed during 1950-54. Approximately 9 percent of the farms on which irrigation was developed during the past 5 years installed additional wells, and 24 percent of all pumps installed on these farms were lowered.

COST OF IMPROVEMENTS

The wide differences in farm-to-farm costs for improvements during 1950-54 come primarily from the number of wells installed and the total length of the distribution system. Some of the difference was caused by changes in the installed cost of underground distribution systems. The reported per-foot cost of installed underground concrete tile declined almost a third during 1950-54. The average per-farm cost for the various types of improvements alone and in combination is shown in Table 5.

Table 5. Average expenditures during 1950-54 for improvements on irrigated farms developed before 1950 by type of improvement, Texas High Plains

Type of improvement	Average expenditure per farm, 1950-54[1]		
	Sandy land	Heavy land	Area[2]
Expenditure per farm making improvement[3]	$7,600	$5,664	$6,642
Expenditure per farm for:			
Additional wells only	5,024	6,110	5,336
Distribution system only[4]	4,540	2,400	4,234
Distribution system and additional wells[4]	8,440	11,049	8,788
Lowering pumps only	1,049	383	574
Lowering pumps + additional wells	7,619	8,256	8,119
Lowering pumps + distribution system[4]	2,629	4,290	3,667
Lowering pumps + additional wells + distribution system[4]	18,519	10,490	14,058

[1]Includes ASC payments for affected items; total cost of improvement.
[2]Exclusive of Lynn and Terry counties.
[3]Exclusive of natural gas line installation.
[4]Underground concrete tile and portable surface pipe; sprinkler systems not included.

During 1950-54, approximately 85 percent of the operators of "old irrigated farms" averaged $6,642 per farm on capital improvements for maintenance and improvement of farm water supplies. Capital expenditures averaged $2,000 more per farm in the sandy-land area than in the heavy-land area. The average increase in irrigated acres per farm in the heavy-land area was 33.3; the average increase in the sandy-land area was 24.1 acres per farm.

The total initial investment per farm on old farms is unknown. Table 5 shows capital expenditures above the initial development costs. Pump and engine replacement costs on pre-1950 wells are not included. The initial per-acre costs of developing irrigated farms during 1950-54 are shown in Table 6.

The additional capital investment on old farms was slightly more than two-thirds of the total cost of developing a new irrigated farm during 1950-54. Additional capital investment in the sandy-land area closely approaches the 1950-54 cost of developing an irrigated farm. Because of the difference in farm size, per-acre development costs provide a better basis for comparison than total farm development costs. In the sandy-land area, which has a higher proportion of more expensive improvements such as new wells and underground systems, the additional per-acre investment cost on old farms was about 62 percent of

Table 6. Capital investment in irrigation facilities, Texas High Plains, 1954

Item	Average per farm		
	Sandy land	Heavy land	Area[1]
Farms developing irrigation during 1950-54:			
Investment (dollars)	7,702.00	11,450.00	9,810.00
Acres irrigated (acres)	131.4	208.9	175.0
Investment per acre irrigated (dollars)	58.58	54.80	56.04
Farms developing irrigation prior to 1950[2]:			
Additional investment (dollars)	7,600.00	5,664.00	6,642.00
Acres irrigated 1949 (acres)	185.4	262.4	224.3
Acres irrigated 1954 (acres)	209.5	295.7	253.0
1949-54 increase in acres irrigated (acres)	24.1	33.3	28.7
Additional investment per acre irrigated, 1954 (dollars)	36.27	19.15	26.25

[1]Exclusive of Lynn and Terry counties.
[2]Farms making improvements only.

the 1950-54 development costs. In the heavy-land area, where underground distribution systems are fewer and less extensive and a higher proportion of pumps were lowered, the additional capital investment per acre was about 35 percent of 1950-54 development costs.

Additional wells were installed on 55 percent of the old farms and on 9 percent of the farms developed during 1950-54 (Table 2). Redrilled or replaced wells are not included as additional wells. The average well cost per farm on old farms is shown in Table 5. The lower average well cost per farm in the sandy-land area shows the trend toward shallower wells and smaller, less expensive pumps. Declining water levels led to deeper pump settings and an increase in the average well cost on old farms in the heavy-land area during 1952-54.

The accelerated shift to smaller, less expensive pumps in the sandy-land area during 1952-54 is shown by a 7.5 percent decrease from the 1950-51 well cost. The shift in pump size in the sandy-land area, where a higher proportion of new wells was installed, and the deeper initial pump settings on farms developed during 1950-54 is reflected by the difference in cost between wells installed on old farms and those developed on new farms. For the whole area, the 1950-54 cost per well on old farms averaged $4,524; on new farms it averaged $5,283.

Underground concrete tile or aluminum surface pipe distribution systems are relatively new on the High Plains. A few farms were equipped with underground systems in the late 1940's. By the end of the 1954 crop season, 41 percent of the farms containing 45 percent of the irrigated acreage were wholly or partly equipped with closed conduit distribution systems. In the sandy-land area, 46 percent of the farms containing 54 percent of the irrigated acreage have underground or surface pipe distribution systems. In the heavy-land area, 37 percent of the farms and 40 percent of the irrigated acreage are equipped to some extent with underground distribution systems.

There is a wide range in the per-acre distribution system costs among farms. These differences stem from (1) the extent to which a farm is equipped, (2) the topography and layout of the farm which affects the length and layout of the system and (3) the time of installation. The range in per-acre costs for the farms studied is from 86 cents on a heavy-land farm with only 300 feet of underground tile to $84.83 on a rather elaborately-equipped sandy-land farm. In the sandy-land area, the more common cost on farms with a complete or reasonably complete underground system is $30 to $40 per acre. Per-acre costs on heavy-land farms generally are lower than for sandy-land farms. The average per-acre expenditure for underground distribution systems was $19.18 for the sandy land, $11.44 for the heavy land and $14.96 for the area, exclusive of Lynn and Terry counties.

Table 7. Proportion of pumps lowered, Texas High Plains, 1954

Land type	Percentage of pumps lowered[1]	
	Pre-1950 farms	Post-1950 farms
Sandy land	19	16
Heavy land	54	30
Area[2]	37	24

[1]Percentage of total wells on farms developed before 1950 and those developed in 1950-54.
[2]Exclusive of Lynn and Terry counties.

Declining water levels and reduced well performances have forced the lowering of pumps. This method of improving water supplies has been used to some extent since the beginning of irrigation development, but it increased during 1950-54, particularly on farms in the heavy-land area. The proportion of farms on which pumps were lowered is shown in Table 2. The proportion of pumps lowered one or more times from the initial setting is shown in Table 7.

Pumps usually were lowered 10 feet, but since 1952 the number of pumps lowered 20 and 30 feet has increased. The cost of lowering pumps per farm is shown in Table 5. The average cost of lowering an individual pump, exclusive of repair costs that might have been sustained while the pump was out of the well, ranges from $445 in the heavy-land area to $587 in the sandy-land area.

The use of pumping plants fueled with natural gas expanded considerably during 1950-54. About 15 percent of the farms included in the survey were using natural gas by the end of the 1954 pumping season (Table 2). Natural gas main lines are more numerous in the heavy-land area; the proportion of farms using natural gas in this area is twice that of the sandy-land area (Table 2).

Where natural gas is used, the farmer must furnish his own connecting lines. These lines run from the well to a main line provided by the gas company, or to a service line provided by a group of farmers. The average expenditure per farm for natural gas lines was $1,864 during 1950-54. The average cost per well was about $1,000. Because this expenditure reduces fuel costs but does not improve farm water supplies, it was excluded from the tabulations in Tables 3, 4, 5 and 6.

WATER COSTS, 1954

Although 1954 butane prices averaged 1.5 cents (18.7 percent) lower than 1949 prices and approximately 15 percent of the farms surveyed were using natural gas for pumping, which is a cheaper fuel, the 1954 average water cost per acre was more than double the 1947-49 average. Increases in cost were caused by increased hours of pump operation, capital additions and a decrease in the acres irrigated per well (Table 8 and Figure 2).

The average rate of water use during 1947-49 was .86 acre-feet per acre and pumping plants operated an average of 930 hours per season.[7] Higher rates of water use and a longer irrigation

season were required during the drouth and near-drouth conditions of 1950-54, particularly during the last 3 years (Figure 1). Water-use estimates for 1954 indicate an average of 1.48 acre-feet per acre irrigated, a 72 percent increase over 1947-49 rates.[2]

The average hours of pump operation in 1954 are shown in Table 8. The 1954 average was 2,207 hours, or 135 percent more than the 930 hours of pump operation per season reported in 1947-49.

The effects of increased hours of pump operation are shown in per-acre operating costs (Table 8). Increased hours of plant operation are not wholly responsible for the difference in operation costs between sandy-land and heavy-land farms. Lower per-acre water costs on heavy land farms are caused mainly by the greater use of pumping plants fueled with natural gas and a larger irrigated acreage per well.

The investment in irrigation facilities on farms developed during 1950-54 and the added investment in facilities on farms developed before 1950 are shown in Tables 5 and 6. Some of the reasons for differences in the installed cost of a plant are discussed in the preceding section on "Cost of Improvements." Pre-1950 development costs were not obtained in the 1955 survey. As bases for calculating overhead costs on old farms, an estimate of $4,500 per well was adopted for all wells developed before 1950. This estimate is slightly higher than the average cost reported in TAES Bulletin 745. A higher investment cost in pre-1950 wells was adopted to compensate for the additional investment incurred through the lowering of pumps.

Assuming a pre-1950 development cost of $4,500 per plant, the 1954 average initial investment on old farms is $69.35 per acre on sandy-land farms, $46.75 on heavy-land farms and $57.60 for the area, exclusive of Lynn and Terry counties. In the sandy-land area, the present per-acre investment in irrigation facilities of all types is $10.77 greater on old farms than on those developed during 1950-54 (Table 6). In the heavy-land area, where fewer new wells and less extensive distribution systems have been installed, the present initial investment is $8.05 per acre less on old farms than on new farms.

Excepting the cost of natural gas lines, Table 6 includes the cost of all capital improvements made on the surveyed farms during 1950-54. The average initial per-acre investment in irrigation facilities is based on the total cost of all facilities divided by the acres irrigated during 1954. These estimates, both in Table 6 and the per-acre investment costs, include the cost of farm distribution systems. These systems provide some benefit by eliminating or reducing transmission losses. The data on which this report is based do not provide sufficient information to determine these benefits; consequently, neither the overhead nor the operating costs of a farm distribution system are included in the costs in Table 8. Overhead costs in Table 8 include an allowance for depreciation, interest, taxes and insurance on the initial investment in wells and subsequent pump lowering costs for all wells used during the 1954 irrigation season.

Table 8. Average water cost per irrigated acre related to hours of operation and predominant soil textures, Texas High Plains, 1954

Land type	Hours of plant operation	Average cost per irrigated acre[1]		
		Overhead	Operating	Total
		— — — — Dollars — — — —		
1954:				
Sandy land	2,231	7.91[2]	10.02[3]	17.93
Heavy land	2,058	5.60[2]	7.68[3]	13.28
Area average[4]	2,207	6.47[2]	8.58[3]	15.05[3]
1947-49:				
Area average	930	3.25	3.81	7.06[5]

[1]Average for all types of plants.
[2]Pre-1950 developments at an estimated cost of $4,500 per plant.
[3]Does not include labor for plant attendance.
[4]Exclusive of Lynn and Terry counties.
[5]Based on data in Table 11, TAES Bulletin 745 and Table 3, TAES Bulletin 756.

The effects of increased investment on per-acre water costs are shown by a comparison of the 1954 and 1947-49 overhead costs per acre (Table 8). For the farms surveyed, overhead costs, exclusive of those on farm distribution systems, increased almost 100 percent during 1950-54. The data in Bulletin 745 are not sufficiently detailed for determining overhead costs by major soil types during 1947-49. Because of the higher investment in new well developments and smaller irrigated acreages per well in the sandy-land area, overhead costs in this area are $2.31 per acre greater than in the heavy-land area.

The number of acres irrigated per well influences total water costs. The effect of acres irrigated per well is shown in Figure 2. Cost estimates on which this figure is based are group averages of the per-acre water costs on all wells regardless of the fuel or type of power unit used. For the wells enumerated in this study, differences in the acreage irrigated per well have a sim-

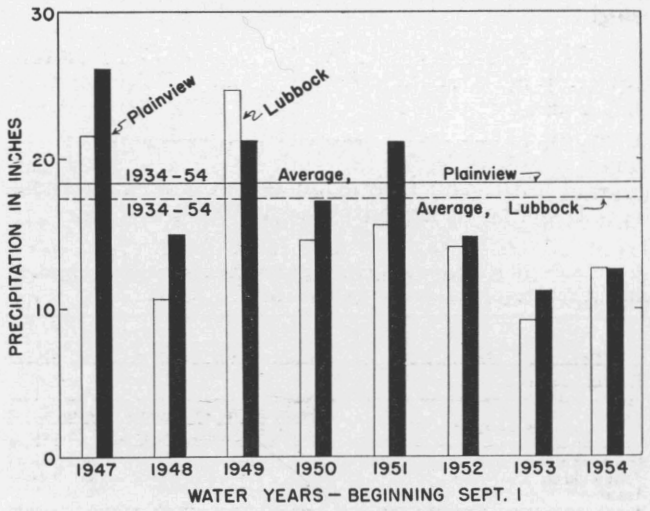

Figure 2. Annual and average precipitation by water years, Lubbock and Plainview, Texas.

Table 9. Irrigated and nonirrigated cotton and grain sorghum yields on sandy and heavy soils, 1947-49 average and 1954, Texas High Plains

Year	Average yield per harvested acre, in pounds							
	Sandy land				Heavy land			
	Cotton		Grain sorghum		Cotton		Grain sorghum	
	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland
1947[1]	536	278	2,305	1,055	492	196	2,498	955
1948[1]	402	106	2,272	606	415	73	2,598	289
1949[1]	460	296	2,609	1,513	476	295	2,636	1,271
Av. 1947-49[1]	466	227	2,395	1,058	461	188	2,585	914
1954	548	122	2,751	409	603	[2]	3,224	[2]

[1]Abstracted from Table 13, "Use of Irrigation Water on the High Plains," TAES Bulletin 756.
[2]None reported.

ilar, although not necessarily the same, effect on per-acre water cost irrespective of type of fuel or equipment used. During 1954, the acres irrigated per well ranged from 15 on a sandy-land farm to 600 on a heavy-land wheat and sorghum farm. The acres irrigated per well averaged 95 in the sandy-land area, 142 in the heavy-land area and 119 for the area, exclusive of Lynn and Terry counties.

Per-acre water costs rise sharply once the acreage irrigated per well falls below 90 acres. Per-acre water costs on wells serving 30 acres or less are three times those for wells serving 71 to 90 acres and 4.5 times those for wells serving 151 to 170 acres. The increase in per-acre water cost is caused by an increase in per-acre investment costs, as indicated by the rise in overhead costs (depreciation, interest, taxes and risk), and by greater hours of pump operation per acre, as indicated by the rise in operating costs (fuel, oil and repairs).

During 1950-54 the acres irrigated per well declined 26 percent with 8 percent of the decline occurring between 1953 and 1954 (Table 1). Figure 2 also indicates that a further decline in acres irrigated per well will increase per-acre water costs.

CROP YIELDS, 1954

Yields of irrigated cotton and grain sorghum were higher in 1954 than in previous years. Dryland cotton yields in the sandy-land area were up slightly over those of the preceding 3 years, but were considerably lower than those of 1947-49. Dryland grain sorghum yields in 1954 were less than half the 1947-49 average (Table 9).

LYNN AND TERRY COUNTIES

Most of the irrigation development in these counties has occurred since 1950 with a particularly sharp increase beginning in 1953 and carrying on into early 1955. Data for these counties have been excluded from the comparison presented earlier in the report. Because of the newness of these developments and the size and type of equipment used, such comparisons are not valid.

Table 10. Acres irrigated and investment in irrigation facilities, Lynn and Terry counties, 1954

Item	Unit	Average	
		Lynn	Terry
Acres irrigated per farm	Acres	134.0	266.4
Acres irrigated per well	Acres	47.8	102.4
Pump operation	Hours	3,213	2,158
Investment per acre in:			
Wells	Dols.	59.35	74.39
Surface and underground pipe[1]	Dols.	9.85	20.06
Sprinkler systems[1]	Dols.	7.22[2]	37.89
Investment per irrigated farm	Dols.	9,109.00	24,819.00
Investment per irrigated acre	Dols.	67.97	93.16

[1]Investment per acre on farms so equipped.
[2]One small sprinkler system.

Development conditions are radically different between the two counties. In Lynn county there is a predominance of small 4 to 5-inch and a few 3-inch pump-equipped wells. Generally, there is more than one well per farm. Wells are interconnected and water is delivered to the furrows through closed conduits, usually aluminum surface pipe. In Terry county, the wells are commonly equipped with 8-inch pumps. By the beginning of the 1955 season, all the farms studied were equipped with sprinkler systems.

Some details concerning irrigation development in Lynn and Terry counties are shown in Table 10.

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