SIXTEENTH CENSUS OF THE UNITED STATES: 1940

IRRIGATION OF AGRICULTURAL LANDS

TABULAR AND GRAPHIC PRESENTATION

OF

SPECIFIED IRRIGATION CENSUS STATISTICS

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Irrigation Monograph.—A Tabular and Graphic Presentation of Specified Irrigation Census Statistics (paper bound).

Agriculture volumes II and III and the volume "Irrigation of Agricultural Lands", and "Drainage of Agricultural Lands" are comprised of State bulletins. Separate bulletins for each State are available. Separate chapters of Agriculture volume III are also available.
CONTENTS

Introduction------------------------------------------ 1
Definitions and explanations--------------------- 1
The Census year------------------------------------- 1
An irrigation enterprise-------------------------- 1
A primary enterprise------------------------------- 1
A supplemental enterprise------------------------ 1
Farms irrigated------------------------------------ 1
Area irrigated------------------------------------- 1
Area irrigable------------------------------------- 1
Capital invested----------------------------------- 2
Maintenance and operation------------------------ 2
Main canals and laterals-------------------------- 2
Pumping plants------------------------------------- 2
The drainage basin------------------------------- 2

General discussion------------------------------- 3

I-VIII. Annual precipitation, departure from normal, 1889 to 1959, and the monthly precipitation for the water year (October 1958 through September 1959) for each of the 20 irrigation States----------------------------- 6

I-IX. Areas irrigated, area irrigated, and average annual cost of maintenance and operation of irrigation enterprises, census of 1890 to 1940, by States arranged in order of area irrigation works were capable of supplying with water in 1940------------------------------- 14

I-X. Areas irrigated, area irrigated, and average annual investment per acre of irrigation enterprises, census of 1902 to 1940, by specified drainage basins------------------------------------- 17

I-XI. Areas irrigated, 1902 to 1939; area works were capable of supplying water, area irrigable, capital invested, and average investment, 1920 to 1940; and average annual cost per acre of maintenance and operation of irrigation enterprises, 1919 to 1929; by source of water supply------------------------------------- 19

I-XII. Areas, capital invested, and average investment per acre, 1890 to 1940, and by type of irrigation enterprise, 1930 to 1940------------------------------------- 21

I-XIII. Number and yield of pumped and flowing wells, average yield of pumped wells, 1910 to 1940; and average lift of pumped wells, 1940; by States------------------------------------- 23

I-XIV. Number and total capacity of pumps, 1910 to 1940; average capacity of pumps and average capacity of prime movers, 1910 to 1940; and average lift of pumps, 1930 to 1940; by States------------------------------------- 25

CHARTS

TABLES

Precipitation and departures from normal: 1889, 1899, 1909, 1919, 1929, 1939, and 1959------------------------------------- 27

Monthly and annual precipitation with annual departure for calendar years, 1900 and 1959; and monthly and total precipitation with departure for period for water year, October 1958 through September 1959------------------------------------- 27

Irrigation enterprises, area existing irrigation works were capable of supplying with water, area irrigable in enterprises, and estimated total cost of existing enterprises, 1910 to 1960; Farms irrigated, area irrigated, and capital invested, 1890 to 1940; by States------------------------------------- 28

Area irrigated, 1902, 1919, 1929, and 1939; area existing works were capable of supplying with water and area irrigable, 1920 to 1940; capital invested and average investment per acre works were capable of supplying with water, 1920 to 1940; and average annual cost per acre of maintenance and operation of irrigation enterprises, 1919 to 1959; by source of water supply, by States------------------------------------- 28

Area irrigated, 1909 to 1939; area works were capable of supplying with water, area irrigable, capital invested, and average investment per acre works were capable of supplying with water, 1920 to 1940; and average annual cost per acre of maintenance and operation of irrigation enterprises, 1919 to 1959; by type of irrigation enterprise, by States------------------------------------- 31

Length of canals, 1900 to 1940; capacity of canals at main headings, and number and yield of pumped wells, 1910 to 1940; and average pumping lift from pumped wells, 1940; by States------------------------------------- 34

Areas, capital invested, average investment per acre, and proportions of totals, by type of enterprise, 1890 to 1940; length of canals, 1900, 1920, 1930, and 1940; and capacity of canals at main headings, and number and yield of pumped wells, 1920 to 1940; and average pumping lift from wells, 1940; by specified drainage basins------------------------------------- 38

Number and yield of flowing wells, number and capacity of pumps, and average capacity of prime movers, 1910 to 1940; average lift of pumps, 1920 to 1940; by States------------------------------------- 40

Number and yield of flowing wells; number, capacity, and average lift of pumps; and average capacity of prime movers, 1920 to 1940; by specified drainage basins------------------------------------- 40

Pipe lines—total length, 1910 to 1940; and lengths by materials of construction and size, 1930 and 1940; by States------------------------------------- 42

IV
A TABLE AND GRAPHIC PRESENTATION OF SPECIFIED IRRIGATION CENSUS STATISTICS

BY MILIO B. WILLIAMS

INTRODUCTION

Statistics relating to the irrigation of agricultural lands and irrigation enterprises in the United States have been gathered by the Bureau of the Census, at somewhat irregular intervals and with varying degrees of completeness, over a period of 60 years. The First Census of Irrigation was taken in 10 western States in 1890, as part of the Eleventh Decennial Census of the United States. Statistics of Irrigation for 1890 and later were published in a separate volume, "Agriculture by Irrigation in the Western Part of the United States." The Twelfth Decennial Census taken in 1900 included, as a part of the Census of Agriculture, irrigation inquiries in the same 10 States, but the statistics were published in the State bulletins with the Census of Agriculture. A special Census of Irrigation, covering irrigation and drainage in 15 States, was taken in 1902 and the statistics were published in Bulletin of the Census No. 16, 1904. This 1902 Census of Irrigation was the first to display irrigation statistics by drainage basins of principal rivers and streams. Since 1902, Irrigation Censuses have been taken as a part of the Census of Agriculture in the years of 1910, 1920, 1930, and 1940, but the data have been published for each Census, except 1920, in separate State bulletins. Summary volumes containing State maps were published for the Irrigation Censuses of 1920 and 1930. A summary volume and separate irrigation State maps, by drainage basins, were published for the 1940 Census.

This monograph presents data in tabular and graphic form for the principal comparable statistics compiled by the Census of Agriculture up to and including those of 1940. Statistics regarding number of irrigation enterprises, number of farms irrigated, areas involved, capital invested, costs of maintenance and operation, and inventories of physical works for the Census years are related graphically in parallel to indicate trends with time. More detailed statistics for recent censuses than are shown in the following tables and graphs may be obtained for each State from the Bureau of the Census State bulletins. The report "Irrigation of Agricultural Lands, 1940," for sale by the Superintendent of Documents, Government Printing Office, Washington, D.C.

The available statistics are arranged in accordance to area, type, and water source groups and presented in summary and for individual groups by States (17 western States and Arkansas and Louisiana), by specified drainage basins (10 major basins in the western States and temporary tributaries), by irrigation enterprise (individual and partnership, cooperatives, irrigation districts, commercial companies, United States Bureau of Reclamation projects, and "all other" types grouped), and by source of water supply (surface sources, underground sources, and mixed, and all other sources grouped). The "all other" group under type of enterprise includes projects of the United States Office of Indian Affairs, State enterprises, city and/or sewage enterprises, and Reclamation Districts in California. The "surface source" group of water supplies consists of streams, lakes, springs, stored storm water, waste, sewage, or drainage water diverted by gravity and/or pumped. The "underground source" group of water supplies consists of wells pumped and/or flowing, and the "mixed and all other" group includes city water, waste streams and wells, and all other mixed or not reported sources diverted by gravity and/or pumped.

Definitions and Explanations

The Census year is the year in which the actual enumeration of irrigation enterprises was made.

1 Due to wartime conditions many statistics published herein are not shown graphically as originally planned.
2 Special acknowledgment is due Gladys L. Maga for the preparation of tables.
Land is classified as irrigated which had water supplied to it for agricultural purposes by artificial means or by seepage from canals, reservoirs, or irrigated lands. Land which is flooded during high-water periods is classified as irrigated if water is caused to flow over it by canals, canals, or other artificial means, but is not classified as irrigated if the overflow is due to natural causes alone. Land which has natural ground water sufficiently near the surface to support plant life and to which no water is artificially applied at any time, is not classified as irrigated.

Areas that existed works were capable of supplying with water represent the area which the constructed works, as they existed on January 1 of the irrigation Census year, could serve regardless of whether or not the land was farmed.

Irrigation represents the extent of the area that the constructed works, as they existed in January 1 of the irrigation Census year, could serve regardless of whether or not the land was farmed.

Capacity at main canal heading as the capacity of the main canal heading, pumping plant, or other structures used for receiving water from a surface source into a distribution system and does not necessarily mean the capacity of a canal or other main conduit. A second-foot, or cubic foot per second (sec.-ft. or c.f.s.), is the rate of discharge of water flowing in a channel when the cross-sectional area is 1 square foot and the average velocity is 1 foot per second.

Pumping plants.—The census of pumping plants was confined to those used for lifting irrigation water and were enumerated and tabulated according to the kind of motive power, i.e., "electric motors," "internal-combustion engines," and "other power"; and by type of pump, i.e., "centrifugal," "turbine," "plunger," and "other pumps." Steam, water, and wind were classified in "other power." Hydraulic rams, air lifts, rotary and "other pumps" were classified as "other pumps." The inquiry regarding the average lift or distance the water was lifted is called the vertical distance, in feet, between the average elevation of the water in the source of supply when the pump is running at usual capacity and the average elevation to which the water is lifted. It does not take into account friction and velocity heads. The statistics for 1940 show separately the lifts from wells and from all sources to indicate the lifts of ground water in areas irrigated with water from other sources.

Capacity of a pump and yield of a well is given in gallons per minute (g.p.m.). Approximately 450 gallons per minute equals 1 second-foot.

Capacity of a motor or engine is given in horsepower (hp.). One horsepower is the energy required to lift 33,000 pounds through a vertical distance of 1 foot in 1 minute.

Maintenance and operation refers to the costs of maintaining the irrigation enterprise, including ordinary cleaning and repairs, and operation costs, including costs of fuel, electric energy, and amount paid the personnel. The average annual cost of maintenance and operation per acre is the ratio of the annual cost to the acreage irrigated in the crop year enumerated. This item does not include assessments for payments principal and interest on bonds, notes, warrants, or for special or unusual expenditures.

Main canals and laterals.—A main canal is any open conduit conveying water from the source of supply to the tract of land to be irrigated or to a laterage pumpingplant. A lateral is a branch of a main canal conveying water from a main canal to one or more farms. Main canals and laterals are tabulated as "canals." Farm ditches which distribute water to fields within the boundaries of the individual farm are not included.
Precipitation for Census Years

The Irrigation Census of 1940 completed a span of 50 years in which the Federal Government has gathered statistics on irrigation. Table 1 shows the 8 individual years for which irrigation enumerations were made; and the mean annual precipitation and departures from normal for those years, as recorded by the United States Weather Bureau. The average monthly precipitation, by states, for the water year October 1939 through September 1940, is given in table 2. These data, together with those for recorded rainfall and departures from normal for all years from 1890 to 1939, are presented graphically in charts VII to VIII. An analysis of these figures indicates that in most States the annual precipitation was below normal in most of the census years. In many sections of the West, the area most affected by variations in the amount and distribution of precipitation are land reported as irrigated pasture. This acreage seems to accord largely with the fluctuations in the amount of water available for pasture irrigation in the spring and fall, before and after the requirements of other more valuable crops are satisfied, a relation and practice which should be taken into consideration in the use of irrigated-pasture data. When a census year falls in, or at the end of, a dry period, or period of excessive precipitation, the available water supply, areas irrigated, and crop yields are correspondingly affected. Therefore, users of Census data should take into consideration, in their interpretation of Irrigation Census statistics, the precipitation factor for the years concerned.

Precipitation for the calendar year 1939 and the water year October 1939 through September 1940 was below normal in the 19 Irrigation States. Colorado, California, and Nebraska received the least rainfall during 1939, amounting to 65, 67, and 72 percent of normal, respectively. Idaho, Kansas, eastern Oregon, eastern Washington, and Wyoming received approximately 77 percent of their normal precipitation (see tables 1 and 2).

Irrigation Statistics by States

Table 3 and chart IX present historic Census statistics summarized and by States on irrigation in the 17 western States and Arkansas and Louisiana for the Decennial Censuses, 1890 to 1940. The statistics show number of irrigation enterprises, farms irrigated, area involved, capital invested, and average annual costs of maintenance and operation.

As graphically shown on summary chart IX the most rapid expansion of irrigated agriculture in these 19 States took place prior to 1920, reaching the greatest acceleration in the decade 1899 to 1909, when the area irrigated was increased by 8,665,795 acres compared with an increase of 4,788,431 acres in the 10-year period 1909 to 1919, and an expansion of only 1,310,385 acres in the 20 years between 1919 and 1939. Although the number of irrigation enterprises increased during each decade, the size of enterprise, in acres irrigated, only increased up to 1919. During the 20 years from 1919 to 1939, the size of enterprise decreased in both area and number of farms irrigated, as is shown by the table following:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>1890</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres irrigated per enterprise</td>
<td>251.8</td>
<td>303.5</td>
<td>226.9</td>
<td>298.7</td>
<td>282.9</td>
<td></td>
</tr>
<tr>
<td>Number farms per enterprise</td>
<td>3.9</td>
<td>5.9</td>
<td>3.6</td>
<td>3.5</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Acres per farm irrigated</td>
<td>66.6</td>
<td>66.8</td>
<td>66.0</td>
<td>65.7</td>
<td>65.1</td>
<td>66.0</td>
</tr>
<tr>
<td>Cost of maintenance and operation per acre irrigated</td>
<td>$1.07</td>
<td>$2.45</td>
<td>$2.77</td>
<td>$2.98</td>
<td>$2.86</td>
<td></td>
</tr>
</tbody>
</table>

The average size of the irrigated farm increased to 88.7 acres in 1900, but decreased to 72.0 acres in 1939. During the 20 years prior to 1940, the trend in number and size of irrigation enterprises and irrigated farms has been materially affected by the increased number of individual and small partnerships for irrigation from underground water by pumping. In recent years, the number of irrigation enterprises has been increased in many areas by the formation of projects to supply supplemental water. In 1939, the 91,679 enterprises reported were composed of 50,628 primary enterprises averaging 260.9 acres irrigated per enterprise, and 11,155 supplemental enterprises averaging 280.6 acres per enterprise.

The capital invested, as reported by irrigation enterprises, has continuously increased in total and in average investment per acre based on the area that existing works were capable of supplying with water.

The reported capital invested by individual States does not in all cases follow an upward trend. Some States show an actual decline in total and average investment per acre, while others display a steeper trend upward than indicated in the "Summary" (chart IX). In 1940, the average investment was $37.60 per acre for the 19 States; while Kansas with $18.12 per acre and Arizona with $98.84 per acre represent the extremes in investments. Arizona statistics show a continuous increase in investment per acre, while the average per acre in Kansas decreased 50.4 percent in the 20-year period 1920 to 1940.

The absence of records for persons reporting and the lack of knowledge of the actual costs of construction and water rights of the older irrigation projects and of many individually owned irrigation systems are elements of uncertainty in the investment figures of all censuses. These elements, however, probably do not affect the trends materially. In individual States, drainage basins, or counties, the trend in investment has been sometimes affected by the abandonment of portions or all of incomplete projects, the development of costly supplemental water supplies or the addition of betterment, such as lined canals, pipe lines, increased pumping facilities, or water-spreading works to augment ground-water storage. In many instances the construction of multipurpose water-conservation projects which contribute to irrigation water supplies may locally raise the per acre investment for lands already under irrigation or lower the average investment for new lands brought under water, depending upon the proportion of the costs of the multipurpose enterprise allocated to irrigation. In general, the costs per acre for the development and application of irrigation water from underground sources is considerably higher than the costs per acre of surface water, Therefore, irrigated areas which expand by increased pumping from wells show higher capital costs. Many areas, heavily pumped, experience a lowering of the ground-water level which requires the abandonment of initial pumping equipment and the installation of more expensive equipment capable of making the higher lift of the required water. In other pumped areas, additional costs become necessary to purchase water rights, install physical works for spreading surface run-off water, or to bring in a supplemental supply.

The average annual cost per acre irrigated for maintenance and operation of irrigation enterprises, based on irrigated areas reporting this item in the crop year 1939, was $1.07 per acre for the 19 States. This rose to $2.45 in 1939, and to $2.77 in 1936 but dropped to $2.86 in 1938. This item seems to be fairly constant between censuses, but varies greatly between areas. The States having mostly surface supplies of water diverted by gravity, such as Colorado, Montana, and Wyoming, report average annual costs for maintenance and operation of less than $1.00 per acre irrigated; while States dependent more or less upon pumped water supplies, like Arkansas, Arizona, and California, reported average costs of maintenance and operation for 1939 of $5.46, $5.00, and $4.73 per acre, respectively.
Irrigation Statistics by Drainage Basins

Irrigation statistics have been obtained according to selected drainage basins, i.e., areas drained by a large stream system or a number of small streams, for the Census of 1926, 1930, 1935, and 1940 covering a period of 35 years. The principal data are presented in tables 4, 9, and 11 and charts X. The Census of 1902 shows only areas irrigated in the crop year enumerated, capital invested, and lengths of canals. Area for which existing irrigation works were usable or supplied with water, irrigable area, number and capacity of wells used for irrigation, and data relating to pumping equipment are also shown in tables and charts for the Censuses of 1920, 1930, and 1940.

The irrigated States of the West lie wholly, or in part, within 12 major drainage basins. Data for 10 major drainage basins and 10 secondary or tributary basins of these major basins are displayed graphically. The area drained by the Missouri River, although tributary of the Mississippi River, is considered a major drainage basin. The lower Mississippi River and Rio Grande flowing into the Gulf of Mexico are each treated as major basins. The remaining Gulf of Mexico streams are grouped in one basin. The Colorado River Drainage Basin is divided into an upper basin and a lower basin at a point in the river below the mouth of the Paria River at Lee Ferry near the Utah-Arizona line. The Great Basin is divided into two areas named for the prehistoric lakes, "Bonneville" and "Labonoe." The irrigation basin called the Sacramento-San Joaquin Delta and tributary stream basins include the Sacramento and San Joaquin River systems and their delta areas. Streams tributary to San Pablo and San Francisco Bays are considered part of the Pacific Ocean stream basin, exclusive of the California streams of the Columbia and the Fraser Rivers, and the Sacramento-San Joaquin Delta and tributary streams.

Data are not plotted graphically for the drainage basins, Red River of the North representing all streams flowing from the United States into Lake Winnipeg, Canada, or for Whitewater Draw and Vasumri Wash, Arizona, closed basins in the Gulf of California and watered.

Specific boundary lines of drainage basins are delineated on separate, 3 color, State irrigation maps, and a 4 color composite map for the 17 Western States, Arkansas, Louisiana, and Idaho. A report on the Southern Great Basin, by Drainage Basins—1939, is available for sale by the Superintendent of Documents, Washington, D. C.

Areas Irrigated

The area irrigated in 1929 in the 17 western States and Arkansas and Louisiana, reported by the Census of Irrigation (table 3), was 21,023,739 acres an increase of 1,460,195 acres, or 7.4 percent since 1929. This is a greater rate of increase than the 1.9 percent preceding the depression decade of the 1930's, but the rate of the 1929-1930 period when an increase of 33.0 percent was shown. In the 1929 to 1939 period, increases were shown in 15 States and decreases were recorded for Colorado of 5.1 percent, Louisiana of 0.8 percent, and Idaho of 10.3 percent and Utah of 11.1 percent. The 1939 irrigated areas by principal drainage basins show increases in all basins, with the exception of the Rio Grande which shows a decrease of 2.8 percent, since 1929.

The distribution of 1929 irrigated areas by type of irrigation enterprise shows increases for all types, with the exception of "Commercial," which shows a decrease of 17.3 percent, and "all other" (miscellaneous), 2.4 percent. The transfers, during the past decade, of "Commercial" and "all other" types of enterprises into water-user organizations such as "Cooperatives," "Irrigation districts," and "Government projects" provided the main changes for the changes by type of organization. The greatest decades increases of area irrigated, by type of enterprise, were reported by individual and partnership, 23.0 percent, cooperatives, 36.1 percent, and bureau of Reclamation, 336.9 percent.

Chart XII shows graphically the historic trends of areas by type of enterprise related to investment. For the Census year 1929, the area and investment involved in development for supplemental supply is graphically presented in the supplemental investment shown; this is also added to the primary investment column. Investment for earlier Census years was not available for primary and supplemental projects unsegregated. Therefore, the total investment (primary plus supplemental) in 1940 is comparable with the investment of previous years. Likewise, the average investment per acre is based on totals for more years except 1940 when separate averages for primary and supplemental enterprises are shown. An average based on totals for 1940 is also shown because the total investment applies to the total primary acreage. In the chart for the individual type of enterprise, an average investment per acre based on total investment is not shown because the supplemental investment usually applies to areas administered under one or more types other than the one credited. This is also true of chart XI which presents areas and investments by source of water supply. However, since less than 10 percent of total and 16 percent of total investment is reported in "underground sources" and no supplemental enterprises are reported in "other mixed sources," the total averages are shown in Table 5.

Capital Invested

The total investment in irrigation works and water rights reported by enterprises in the 1940 Irrigation Census for the 17 western States and Arkansas and Louisiana continued the trend of the previous years with an increase of $125,346,411, or 17.8 percent, since 1935. The change in investment per acre, based on the area irrigation works were capable of supplying with water was from $35.00 in 1935 to $67.00 in 1940, indicating that the costs of additional irrigation works and betterments per unit irrigated also continue to increase, as has been true from the beginning according to Census Records. Likewise, the estimated cost to complete the irrigation works in existing enterprises based on the irrigable lands in those projects changed from $23.17 per acre in 1935 to $35.99 per acre in 1940, an increase of $8.82 per irrigable acre in the projects. Chart XII shows graphically the historic trends of capital invested as related to project areas.

California, with $318,889,218, or 30.3 percent of the total, with a decade increase of 2.5 percent, ranks first in the 1940 Irrigation Census in capital invested in irrigation enterprises, followed by Idaho, with $256,583,302, or 23.8 percent of the total, with a decade increase of 21.4 percent. Investment increases for the decade were reported in both of the western States of the States of Arkansas and Louisiana, where irrigation is primarily pumping water for rice, showed capital decreases of 16.6 and 25.8 percent, respectively, but the number of irrigation enterprises increased in both States. The irrigated area in Arkansas increased 6.8 percent. Some of the factors which caused the decreases are revealed by the statistics of losses and gains in capital, which indicate considerable shift of location of irrigation practice, by counties and parishes, within these States since 1935. Such shifts required the abandonment of old wells and pumping plants, many of which were installed prior to 1920 at high costs, and the installation of new wells and/or pumping equipment. Irrigation statistics of the Census of 1940 compared with 1930 also indicate a change from steam and internal-combustion engines to more efficient electric motors at lower cost per horsepower. There were indications that new wells and wells installed during the decade 1930 to 1940 cost less than those they had replaced which were of the earlier installations. The Columbia River Drainage Basin ranks first of the 12 principal drainage basins in capital invested in irrigation enterprises ($265,823,302, or 19.6 percent of the total), and also reported the greatest decade increase ($49,168,168, or 31.2 percent). The Missouri River Drainage Basin ranks second ($179,755,538, invested, or 17.1 percent of the total, with a decade increase of $43,943,517, or 31.7 percent); and the Sacramento-San Joaquin Delta and tributary streams Drainage Basin ranks third ($172,004,939, or 16.2 percent of the total, with a decade increase of $46,797,246, or 3.9 percent).

By type of organization, irrigation districts continue to lead in investment with $266,737,810, or 25.3 percent of the total. An increase within this group of$25,240,090, or 10.0 percent; and cooperatives rank third, with $284,140,876, or 25.3 percent of the total, a decade increase of 25.0 percent.

Irrigation Statistics by Sources of Water Supply

The Irrigation Census of 1940 grouped various sources of water supply into (a) "primary source," (b) "supplemental," sources from which the principal part or all of the water is supplied for irrigation of the land involved, and (c) "supplemental sources" (from which a part of the supply of water is obtained to supplement the inadequate primary supply). These two groups are, in turn, segregated into the various surface and underground sources.

Irrigation from streams by gravity and/or pumped, and used alone or in connection with water from wells, continued to be the major supply of irrigation water.
The total area reported entirely irrigated from streams was 16,054,923 acres in 1929, comparable to 14,982,649 acres in 1929, or an increase of 7.4 percent. The area reported as irrigated entirely from wells, either pumped or flowing, was 23,510,142 acres in 1929, comparable to 2,117,012 acres in 1929, or an increase of 952.4 percent. However, areas irrigated entirely from flowing wells decreased 14.4 percent, and those from wells, pumped and flowing, increased 24.0 percent. Indication now is that wells are being pumped. This transition is particularly true in the States of Utah, New Mexico, and Louisiana. The area reported as irrigated from all sources other than entirely from streams or entirely from wells was 2,372,205 acres in 1929, comparable to 2,476,803 acres in 1929, or a decrease of 0.8 percent.

Areas irrigated entirely from streams diversions increased in 15 States and decreased in 6 States from 1929 to 1929. The greatest increases were reported in Wyoming, 257,153 acres, or 22.6 percent; and Utah, 222,579 acres, or 47.2 percent; and Montana, 169,747 acres, or 11.4 percent. The greatest decreases were reported in Colorado, 130,342 acres, or 4.1 percent; and Arizona, 81,082, or 29.8 percent. Areas irrigated entirely from wells, increased in 15 States and decreased in 4 States. The greatest increases were reported in Texas, 87,900 acres, or 32.6 percent; in California, 54,342 acres, or 24.5 percent; in Kansas, 54,342 acres, or 24.5 percent; and Nebraska, 26,562 acres, or 22.2 percent; and Utah, 3,717 acres, or 18.9 percent.

The area irrigated entirely from streams gravity and wells increased 1,182,299 acres or 7.5 percent. Increases in irrigation from this source were reported in 14 States. Decreases were reported in Idaho, 23,859 acres, or 45.0 percent; and in Montana, 2,198 acres, or 44.6 percent. In 1929, the total for North Dakota and South Dakota, respectively, the only two States that reported no lands irrigated from this source. The net increase for the 19 States reporting was 87,960 acres, or 7.6 percent. Irrigation entirely from springs was 210,373 acres in 1929, an increase of 3.0 percent in the 10 years. Of the total acreage irrigated from springs in 1929, Nevada reported 54,946 acres; Utah, 36,898 acres; and California, 26,858 acres; representing a decrease of 11.4 percent and 27.6 percent for Nevada and Utah, respectively, but an increase of 18.9 percent for California.

Irrigation Works

Tables 8 to 12 present an inventory of irrigation works by States and principal drainage basins for the Censuses of 1940, 1930, and 1920. Table XIV shows the number and capacity of irrigation pumps by States. The marked increase in the number of practically all physical structures during the last decade indicated an increase in installations of betterments and increased efforts to conserve water. The following is a summary of the development of each category:

- **Storage Dams:** The number of storage reservoirs increased from 8,122 in 1930 to 7,709 in 1940, or 5.2 percent. The total storage capacity of reservoirs increased from 24,500,500 acre-feet in 1930 to 32,787,392 in 1940, or 37.6 percent. Although the number of reservoirs reported decreased in a few States, each of the 19 Irrigation States, except Kansas, shows an increase in storage capacity. The statistics, as presented on storage dams and reservoirs for the Census of 1920 do not include some developments installed for other than irrigation purposes.

- **Dams and Reservoirs:** The data are not comparable with those of later censuses when only structures installed primarily for irrigation purposes were included. The increase in storage capacity is the most important development in the conservation of water by storage in the decade 1920 to 1940. The States of Arizona, Nebraska, and Utah and in the principal drainage basins of the Missouri, Colorado, and Columbia Rivers, and the Great Basin, have experienced the greatest increase in storage capacity. The lengths and capacities of canals show only slight increases, indicating the lengths of reported pipe lines of all kinds increased from 17,365.1 miles in 1930 to 21,694.9 miles in 1940, or 26.6 percent. The major portion of this increase was concrete pipe lines installed in California, Arizona, and Texas.

- **Flowing Wells:** The number of flowing wells, (see tables 10 and 11), increased from 4,611 in 1940 to 4,641 in 1940, and their capacities decreased from 629,957 gallons per minute to 566,075, or 8.5 percent.

### Number and Yields of Pumped Wells

Tables 8 and 9 show the number and yield of wells pumped for irrigation, by States and principal drainage basins and chart XIII shows this data by States. The total of 36,279 pumped wells reported in 1940 represents a net increase for the 19 Irrigation States of 11,860, or 20.4 percent, compared to an increase of 1,254,083, or 76.8 percent, during the decade 1920 to 1930.

- **Yields of Pumped Wells:** The yield at the net rate of 32.6 percent in the decade 1920 to 1940 compared to 28.6 percent in the previous decade. The average yield per well was 230 gallons per minute increased to 372 in 1930, which indicates that larger wells are being developed with the more modern drilling and pumping equipment. The output of the 19 Irrigation States, excepting Utah, shows an increase for 1940 over 1930, but with 17 percent increase in pumped well, while the reported yields decreased in Louisiana (28.1 percent), Nevada (6.0 percent), and Washington (6.5 percent). The greatest increases in yields of pumped wells were reported for Texas (2,319), Colorado (2,204), California (1,541), and Nevada (1,254). The greatest increase in yields, gallons per minute, were in California with 4,031,602; Colorado, 1,561,456; Nebraska, 1,425; and Texas, 1,210,024. These yields raised the average per well in these States as follows: California, from 619 gallons per minute to 883; Colorado, from 564 to 767; Nebraska, from 797 to 861; and Texas, from 658 to 692.

- **Pumped Wells:** The pumped wells increased from 1910 to 1940, in the principal drainage basins, excepting the Red River of the North in North Dakota and the Colorado and the Great Basin, which alone reported a decrease of 1,401 wells, or 56.8 percent, representing a decrease of 56.8 percent in the total yield.

### Pumping Equipment

Tables 10 and 11 present comparable statistics on pumping equipment for the Censuses of 1940, 1930, 1920, and 1940, by States and for 1940, and 1940, by principal drainage basins. The average pumping lift is also shown.

- **Pumping Power:** The installed horsepower for pumping water for irrigation in the 19 States increased from 1,251,449 to 1,779,049, or 22.4 percent, during the decade 1930 to 1940. Likewise, the pumps installed increased 27.4 percent in number and 32.4 percent in capacity. The average pumping lift reported for all pumping plants remained static for the decade at 27.4 feet.

- **Use of Electric Power:** The use of electric power increased 241,888 installed horsepower and represents 61.4 percent of the total in 10 years. The installed horsepower of internal-combustion engines increased 226,087 horsepower and represents 35.4 percent of the total.

A marked increase (15,370 to 35,804, or 165.7 percent) took place in the installation of turbine pumps during the decade. Since the due to the increased emphasis placed by the installation of turbine pumps, it can be reasoned that the trend toward turbine pumps will continue for the future. The increase in the use of centrifugal pumps, is indicative of a new development involving pumped wells, since 1930. Although turbine pumps are used in number and require 81.1 percent of the total installed horsepower, centrifugal pumps exceed them in capacity, with 85.4 percent of the total. The average lift for centrifugal pumps is 29 feet compared to 7 feet for the turbine pumps. This higher lift largely accounts for the greater capacity required for the turbine installations. It is notable that the total number of centrifugal pumps decreased slightly. The total capacity increased 10.1 percent and the installed horsepower decreased 3.7 percent, indicating replacements of machinery of higher efficiency.

All States show a marked increase for the decade in the installation of pumping equipment, with the exception of Utah, which reported a decrease of 11.1 percent. California, which reported 15,754 pumps, or 61.2 percent of the total installations, ranks first, followed by Texas, with 6,195 pumps; Colorado and Nebraska, each with 5.6 percent of the total. Marked increases in reported average lifts are shown in Arizona and Texas. The pumping-plant installations in the principal drainage basins increased, with the exception of the Red River of the North, Whitewater Draw, Vacovis Wash, and the Great Basin (which decreased 46.1 percent). In the Sacramento River, the tributary stream basins contain 44.3 percent of the total irrigation pumps in the 19 States. Other Pacific Ocean Basins, exclusive of the Colorado, Columbia, and Klamath Basins, rank second with 21.1 percent. The Missouri River Basin ranks third with 7.6 percent of the total number of pumps installed. However, the Gulf of Mexico streams, other than the Mississippi River and the Rio Grande, rank third in installed horsepower and second in capacity of pumps.