chapter 9 IRRIGATION AND DRAINAGE ON FARMS

VOLUME II GENERAL REPORT



Issued July 1973



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REPORTS OF THE 1969 CENSUS OF AGRICULTURE

Individual County Reports

Eight-page reports have been issued for each county and State,

Volume I. Area Reports

A separate report has been published for each State, American Samoa, Guam, Puerto Rico, Trust Territory, and the Virgin Islands. The report consists of two sections. Section 1 contains State summary data, county summary of selected data, and miscellaneous items by counties; Section 2 contains the detailed county reports.

Volume II. General Report

Statistics by subject are presented in separate chapters with totals for the United States, regions, geographic divisions, and States. The nine chapters are being issued as individual reports as follows:

| Chapter 1 | General Information; Procedures for Collection, Processing, Classification | | | | | | |
|-----------|---|--|--|--|--|--|--|
| Chapter 2 | Farms: Number, Use of Land, Size of Farm | | | | | | |
| Chapter 3 | Farm Management, Farm Operators | | | | | | |
| Chapter 4 | Equipment, Labor, Expenditures, Chemicals | | | | | | |

- Chapter 5 Livestock, Poultry, Livestock and Poultry Products
- Chapter 6 Crops, Nursery and Greenhouse Products, Forest Products
- Chapter 7 Value of Products, Economic Class, Contracts Chapter 8 Type of Farm
- Chapter 9 Irrigation and Drainage on Farms

Volume III. Agricultural Services

This new report contains data relating to agricultural services for the United States by State and county.

Volume IV. Irrigation

Data will be included on drainage basins, land irrigated, crop production on irrigated land, water conveyed, users, and types of organizations.

Volume V. Special Reports

Reports may contain data obtained from supplemental surveys, such as type of farm, horticulture, and farm finance; in addition to information obtained in the census.

Parts 1 to 9. Type-of-Farm Operations. - One for each of nine major type-of-farm classifications.

- Part 10. Horticultural Specialties.
- Part 11. Farm Finance.
- Part 12. Ranking Agricultural Counties.
- Part 13. Forms and Procedures.
- Part 14. Procedural History.
- Part 15. Graphic Summary.
- Part 16. Coverage Evaluation.

Volume VI. Drainage of Agricultural Lands

This report will include agricultural drainage statistics collected from individual farms and from publicly organized drainage projects. ACKNOWLEDGMENTS—Many persons contributed to the 1969 Census of Agriculture. First and foremost are the millions of farm operators, members of their families, and employees who furnished the information.

The Department of Agriculture cooperated at all levels: Local employees in the county offices of the Agriculture Stabilization and Conservation Service, the Farmers Home Administration, the Federal Extension Service, and the Soil Conservation Service aided in the publicity and provided assistance to the farm operators who requested help in filling out the census forms correctly; personnel of the Economic Research Service and the Statistical Reporting Service were especially helpful in the determination of what data should be collected, the tabulations that were needed, and in the analytical review of the tabulations.

Members of the Census Advisory Committee on Agriculture Statistics and representatives from public and private agencies and firms gave generously of their time and effort in establishing the data requirements and priorities for collection and publication of the information.

The press, radio, and television media, especially those relating to agribusiness activities, were most helpful in promoting awareness of the 1969 census among farm and ranch operators and enlisting their cooperation.

Charles Merzel, International Statistical Programs Division, and Ralph Graham and Jack Margolis, Agriculture Division, were responsible for the systems and processing procedures, including clerical procedures and computer programing. John Adkins and Richard Buhrman, Agriculture Division; and Jerry Benesch, Social Security Administration, made significant contributions to the computer programing.

A large part of the clerical operations were performed in the Data Preparation Division, Jeffersonville, Ind., Hobert A. Yerkey, Chief, under the supervision of Rex Pullin, Don Adams, and Rebecca Nesbitt. John A. Blackledge, William Harlan, and John Womack, Agriculture Division, were responsible for the subject matter review in Jeffersonville.

Computer processing was performed in the Computer Services Division under the supervision of James R. Pepal, Chief.

J. Thomas Miller, consultant to the Chief, Agriculture Division, assisted in developing the table format and reviewed much of the text for this volume.

Kenneth R. Norell, Assistant Division Chief, and Earl R. Franklin, Chief of the Irrigation and Drainage Branch, assisted by Joseph A. Horak, Dan Graf, and Arnold Bollenbacher, Chief, Farm Economics Branch, participated in the overall planning and preparation of data and text material for this chapter. R. Daniel Lindquist, Eleanor F. Folk, Aleze L. Harris, and Patricia M. Tyler assisted in writing the specifications, reviewing the data tabulations, and preparing the charts and the text. Helen M. Davenport was responsible for the historical data tables and Helen D. Turner for editing and liaison in the publications area.

The program was under the primary direction of J. Thomas Breen, Chief, Agriculture Division.

SUGGESTED CITATION

U.S. Bureau of the Census, Census of Agriculture, 1969 Volume II. General Report Chapter 9, Irrigation and Drainage on Farms

U.S. Government Printing Office, Washington, D.C. 1973

LIBRARY OF CONGRESS CARD NO. 72-601370 For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price \$1.25 domestic postpaid or \$1.00 G.P.O. Bookstore.

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GENERAL BACKGROUND

Irrigation data presented in this chapter are confined to the statistics provided by farmers and ranchers in the 1969 Census of Agriculture with respect to irrigation practices and results. The subject is expanded in Volume IV, Irrigation, 1969 Census of Agriculture, to cover the operations of organizations (districts, commercial companies, cooperatives, and government agencies) engaged in delivering water for irrigation to irrigators.

The comparability of data for 1969 with those of earlier censuses is discussed in chapter 1 of this volume together with general definitions and explanations for the 1969 Census of Agriculture. Chapter 1 also contains information on how the 1969 census was taken and processed, and factors influencing the accuracy of the data.

In the 50 States, there were 257 thousand farms which reported irrigating at least part of the cropland or pasture within their boundaries. Although this is a small number in relation to the 2.7 million farms and ranches in the entire Nation, irrigation is significantly important in the total agriculture production in the country.

DESCRIPTION OF AREAS COVERED

The tables in this chapter have a consistent format in that the geographic areas for which the data are presented always appear in the following order in the left hand column.

United States total

- 17 Western States and Louisiana (followed by an alphabetical listing of the individual States)
- 30 Eastern States, Alaska, and Hawaii (followed by an alphabetical listing of the individual States)
- Water Resources Areas (numbered 1 through 18)

This grouping was largely determined by the importance of irrigation to the States' total agricultural production. The number of States included, in addition to the 17 standard Western States, has varied from census to census. Louisiana is included with this group for 1969 because of the importance of irrigation to its crop production. It has also been the additional State most frequently included in the irrigation census; the same grouping was used in the decennial census of irrigation in 1959.

Data for water resources areas (or drainage basins) are presented for the first time in volume II of the census of agriculture, although similar area delineations have been used for the volumes entitled "Irrigation of Agricultural Lands" in previous censuses. The water resources areas were planned and delineated by an interagency task force on water-use data and approved by the Water Resources Council. The Council is responsible for the "National Assessments of Water and Related Land Resources," prepared every 5 years beginning in 1968. During the first national assessment, the Water Resources Council recognized the need for a standard set of geographical divisions. They were then developed for the following reasons:

"The standardized geographic areas to be used for analysis are based upon the requirement for a *continuing* study of water supplies and requirements. If the area being analyzed is held constant for the framework studies and assessments, variations in study results due to changes in the size of the study area can be eliminated. In addition, standardization of areas facilitates generation of basic data and improves analysis and communication of results between organizations and levels of interest."¹

The Water Resources Council has published maps of Water Resources Regions as well as the area map shown on the following page. The region boundaries are delineated on the basis of topographic drainage characteristics. The areas, on the other hand, are delineated on the basis of county boundaries and include groups of counties which, as closely as possible, approximate actual drainage-basin boundaries. The areas and subareas bear the same names and codes as regions and subregions. For example, the "Texas Gulf Region (WRR 12) refers to the area draining into the Gulf of Mexico along the Texas shore. The Texas Gulf Area (WRA 12) refers to the counties that approximate the drainage area of the Texas Gulf Region. Water resources subarea data are not presented in this publication. The water resources area concept is necessary for use with the statistics of farms reported in the census of agriculture because a mail-out/mail-back census does not permit locating farms accurately enough to identify them for regions delineated by natural topographic features.

The following listing describes the water resource regions used as the base for delineating water resource areas. Each area is comprised of the counties approximating the water resource region described.

United States Water Resources Areas:

01 New England area—The counties approximating the drainage within the United States that ultimately discharges into (a) the Bay of Fundy; (b) the Atlantic Ocean whose point of discharge is located within and between the States of Maine and Connecticut; (c) Long Island Sound; and (d) St. Francis River, a tributary of the St. Lawrence River.

¹Water Resources Council, United States Water Resources Regions and Subregions for the National Assessment of Water and Related Land Resources, July 1970, (Washington, D.C.: Water Resources Council, 1970) p. 2.





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¹⁹⁶⁹ CENSUS OF AGRICULTURE, VOLUME IV IRRIGATION

02 Middle Atlantic area—The counties approximating the drainage within the United States that ultimately discharges into (a) the Atlantic Ocean, whose point of discharge is located within and between the States of New York and Virginia; and (b) the Richelieu River, a tributary of the St. Lawrence River.

03 South Atlantic-Gulf area—The counties approximating the drainage that ultimately discharges into (a) the Atlantic Ocean, whose point of discharge is located within and between the States of North Carolina and Florida; and (b) the Gulf of Mexico, whose point of discharge is located within and between the States of Florida and Mississippi, including the Pearl River.

04 Great Lakes area—The counties approximating the drainage within the United States that discharges into (a) the Great Lakes System, including the lakes surfaces; and (b) the St. Lawrence River as far east as, but excluding the Richelieu River.

05 Ohio area—The counties approximating the drainage of the Ohio River, excluding that of the Tennessee River.

06 Tennessee area—The counties approximating the drainage of the Tennessee River.

07 Upper Mississippi area—The counties approximating the drainage of the Mississippi River above the mouth of the Ohio River but excluding the drainage of the Missouri River above a point immediately below the mouth of the Gasconade River.

08 Lower Mississippi area—The counties approximating the drainage of (a) the Mississippi River below the mouth of the Ohio River but excluding the drainages of the Arkansas, White, and Red Rivers above the points of highest backwater effects of the Mississippi River in those parts; and (b) the coastal streams, other than the Mississippi River, that discharge into the Gulf of Mexico from, but excluding, the Pearl River to, but excluding, the Sabine River.

09 Souris-Red-Rainy area—The counties approximating the drainage within the United States of the Souris, Red, and Rainy Rivers.

10 Missouri area—The counties approximating the drainage within the United States of (a) the Missouri River above a point immediately below the mouth of the Gasconade River; and (b) the Saskatchewan River.

11 Arkansas-White-Red area—The counties approximating the drainage of (a) the Arkansas River above the point of highest backwater effect of the Mississippi River; (b) the Red River above the point of highest backwater effect of the Mississippi River; and (c) the White River above the point of highest backwater effect of the Mississippi River, near Peach Orchard Bluff, Ark.

12 Texas-Gulf area—The counties approximating the drainage that discharges into the Gulf of Mexico from and including Sabine Pass to, but excluding the Rio Grande and the lower Rio Grande Valley.

13 Rio Grande area—The counties approximating the drainage within the United States of (a) the Rio Grande River; (b) the San Luis Valley, North Plains, San Augustine Plains, Mimbres, Estancia, Jornado del Muerto, Tularosa, Salt, and various smaller closed basins; and (c) the Lower Rio Grande Valley.

14 Upper Colorado area—The counties approximating the drainage of (a) the Colorado River above the Lee Ferry Compact Point which is about 1 mile below the mouth of the Paria River; and (b) the Great Divide closed basin.

15 Lower Colorado area—The counties approximating the drainage within the United States of (a) the Colorado River below the Lee Ferry Compact Point which is about 1 mile below the mouth of the Paria River; (b) the Rios Yaqui, Magdelena, and Sonoita and other lesser streams that ultimately discharge into the Gulf of California; and (c) the Animas Valley, Wilcox Playa, El Dorado Valley, and other smaller closed basins.

16 Great Basin area—The counties approximating the drainage of the Great Basin that ultimately discharges into the States of Utah and Nevada.

17 Columbia-North Pacific area—The counties approximating the drainage within the United States that ultimately discharges into (a) the Straits of Georgia and of Juan de Fuca; (b) the Pacific Ocean, whose point of discharge is within the States of Oregon and Washington, including the Columbia River; and (c) the Great Basin in the State of Oregon.

18 California-South Pacific area—The counties approximating the drainage within the United States that ultimately discharges into (a) the Pacific Ocean, whose point of discharge is within the State of California, which includes the Central Valley; and (b) that portion of the Great Basin, and other closed basins, in the State of California.

19 Alaska area-The drainage within the State of Alaska.

20 Hawaii area-The drainage within the State of Hawaii.

21 Puerto Rico area—The drainage within the Commonwealth of Puerto Rico.

AVAILABILITY OF DATA

Some farm irrigation data on a county basis are available but are not published here because of space limitations. Most of the items of farm data presented in the tables of this chapter may be obtained for counties by referring to volume I, county tables, or by a written request to the Bureau of the Census. A charge may be involved to cover the cost of additional office processing and disclosure analysis to obtain county data not published in volume I. An estimate of the cost of providing such data will be prepared and sent to the user. Other items of data which were tabulated on an "unpublished" basis may also be available on request.

DEFINITIONS OF SELECTED TERMS

Most of the definitions needed for understanding the tables in this chapter have been provided in chapter I, of this volume. A few additional terms and concepts are defined as follows:

Irrigated farms—A farm with any agricultural land irrigated in the census year is classed as an irrigated farm. The acreage irrigated may vary from a very small portion of the land in a farm to complete irrigation of all agricultural land.

Acres irrigated—Any land in farms and ranches to which water was artificially applied in the census year was counted as acres irrigated. Land irrigated prior to but not in the census year is not included. Irrigation may have been used for producing a harvested crop, for pasture or grazing lands, for cultivated summer fallow, or for land planted to a crop intended for future harvest. Land flooded during high water periods was to be included as irrigation only if water was diverted to agricultural lands by dams, canals, or other works.

Acre-feet—The amount of water required to cover 1 acre to a depth of 1 foot is an acre-foot. This is equivalent to 43,560 cubic feet or 325,850 gallons.

Acres fertilized—The acres fertilized on irrigated farms in table 9 is the total acreage of harvested crops or pasture to which commercial fertilizer was applied on irrigated farms. Part of the fertilized area may not be irrigated.

Cropping intensity—The concept of cropping intensity refers to the amount of labor, materials, and equipment services utilized per acre in crop production. In reference to irrigation, the importance of intensity of cropping lies in the fact that increasing intensity means greater gross and net returns. Where water has been the limiting factor, its addition through irrigation usually results, not only in increased yields of crops formerly grown, but also in the production of new crops which return greater income. Such crops usually require greater use of fertilizer, labor, or machine investment.

At the time the format was developed for table 10, "Cropping Intensity on Irrigated and Nonirrigated Farms," classification of the various crops into intensity groups was based largely on the judgement and experience of the agricultural statisticians planning the statistical presentation. Absolute precision in classification was not sought, nor is it considered necessary for the purposes of this table. Later in the census processing, when USDA estimates of average prices received by farmers in 1969 became available, the value of production per acre was calculated for many of the crops at the national level. For representative crops in each intensity group of table 10, values based on 1969 average prices are shown below:

| | Average value |
|--|------------------|
| | per acre |
| | (in dollars) |
| Intensive crops | |
| Торассо | 1,348 |
| Berries | 1,301 |
| Vegetables and melons, excluding sweet corn | |
| and green peas | 621 |
| Orchards and vineyards (bearing and nonbearing | |
| acreage included) | 438 |
| | |
| Woderately intensive crops | 0.40 |
| Sugar beets for sugar | 243 |
| Rice | 211 |
| Peanuts for nuts | 207 |
| Sweet corn | 177 |
| Cotton | 105 |
| Less intensive crops | |
| Field corn | 96 |
| Sovbeans for beans | 62 |
| Sorghums | 56 |
| All hav except sorohum hav | 46 |
| All small grains except rice | 35 |
| | |

It should be noted that these value-per-acre figures do not coincide with the values obtained by dividing the acreage of cropland harvested into the market value of sales reported in the 1969 census on class 1-5 farms for those crops for which separate acreage and sales figures are available.

Wholly irrigated—Wholly irrigated acreage and production of specified crops in table 11 are the sums of these items for farms reporting that all of the harvested acreage of the specified crop is irrigated. No measure of the adequacy of irrigation of individual crops was obtained in the census.

Partly irrigated—If the acreage irrigated of a specified crop was reported to be less than the acreage harvested, it was counted as partly irrigated.

HISTORICAL COMPARABILITY

Publications Since 1890

Beginning with the "Report on Agriculture by Irrigation in the Western Part of the United States at the Eleventh Census: 1890," each *decennial* census has included information on irrigation. Data were presented for all the States and territories which are now encompassed in 16 of the 17 Western States. Oklahoma was omitted. In the 1935 Census of Agriculture and in each subsequent mid-decade census, irrigation data reported by farmers has been published.

Specific attention was directed to irrigation by the Fifty-Seventh Congress when it authorized the Director of the Census "to complete and bring up to date of the crop year of 1902 the statistics relating to irrigation, the area of land reclaimed, the cost and value of the works, and other such information as can be obtained bearing upon the present conditions of irrigation." This census covered not only individual farms using artificial means of supplying water, but also multifarm irrigation "systems." This can be deduced from the 1902 report which indicates that 134,036 farms were served by water supplied from 33,415 "systems." It appears that the word "systems" included the irrigation works of both individual farms and those serving more than one farm.

Beginning in 1910, the decennial censuses have provided more comprehensive irrigation data than the mid-decade censuses, in that data have been collected on "systems," "enterprises," or "organizations" supplying water to farms, in addition to the information obtained from individual farms as presented in this chapter. From 1920 to the current census, this more comprehensive material has been published in separate irrigation volumes:

- 1920–Fourteenth Census of the United States 1920, Volume VII, Irrigation and Drainage
- 1930-Fifteenth Census of the United States 1930, Irrigation of Agricultural Lands
- 1940-Sixteenth Census of the United States 1940, Irrigation of Agricultural Lands
- 1950-Census of Agriculture, Volume III, Irrigation of Agricultural Lands
- 1959-Census of Agriculture, Volume III, Irrigation of Agricultural Lands, and Volume V, Special Reports, Part 2, Irrigation in Humid Areas.

For 1969, a similar special volume for irrigation is being published, 1969 Census of Agriculture, Volume IV, Irrigation.

Units Enumerated

In all the census reports dealing with irrigation the number of farms irrigated are shown. Earlier definitions of what constitutes a farm have varied from that used in the censuses of 1959. 1964, and 1969. Smaller places have been dropped from enumeration as definitions changed. Thus the numbers of farms reported in censuses prior to 1959 are somewhat larger than if the current definition had been used. Acreage differences involved are minor. A difference between the 1959 and 1969 reports results from the use, in 1969, of a long form schedule for enumeration of farms with sales of \$2,500 and over and a short form for small economic units. The regular 12-page form (A1) provided for much more detailed information on farm irrigation than the four-page form (A2). This difference in the source of the data is noted at the top of tables 1 through 13 in this volume. Prior to 1959, farm respondents were not asked to report irrigation water supply organizations as a source of water. The number of farms so served is available in the 1959 and 1969 censuses.

Area Covered

Although the practice of irrigation is expanding rapidly in the more humid parts of the Nation, the 17 Western States have been and still are those where irrigation is most extensive. Irrigation data have been published for this area in each decennial census and a majority of the mid-decade censuses, beginning in 1890. States most commonly added to the 17 Western States have been Arkansas, Florida, Hawaii, and Louisiana.

In 1959, farm irrigation data were obtained for the 48 conterminous States and Hawaii. County data for irrigation on farms is contained in volume I, area reports of the census of agriculture for 1959, 1964, and 1969. For the decennial censuses of 1920 through 1950, county, State, and drainage-basin data on irrigation can be found in the separate special irrigation volumes.

The delineation of drainage basins has not been entirely consistent from census to census. The changes between 1959 and 1969 were dictated by a study made by the Federal Water Resources Council, which resulted in a report, "Water Resources Regions and Subregions for the National Assessment of Water and Land Resources." However, the drainage basins are sufficiently similar, or can be made so by using (subarea) data for adjustment, that reasonable comparability between the decennial publications can be attained.

Subject-Matter Comparability

Essentially all the subject-matter items for which data were reported in the 1959 census are also covered in the 1969 volume. The definition for farms has not changed. This is true for most other items. The 1969 report includes additional subject matter such as quantity of water used on farms by source, and the cropping intensity classification used in table 9 of this report. Prior to 1959, subject matter has varied from much more comprehensive than the recent censuses to minimal.

Evaluation of Data

Comparison of data obtained from irrigation water suppliers (presented in volume IV) with that obtained from farms suggests that (1) farmers underestimate the amount of water used for irrigation; (2) the organizations supplying water overestimate; or (3) both conditions are true. In the United States as a whole, farm irrigators reported using 2.11 acre feet of water per acre, while irrigation organizations reported delivery of a sufficient quantity of water to their farm customers to cover each acre irrigated to a depth of 3.11 feet.

It was evident, in reviewing the records received from farms in some parts of the country, that some irrigators had no basis for estimating water use in terms of gallons, acre-feet, or depth of application. A similar contrast has been noted among engineers and agricultural specialists in planning new sprinkler installations. In some areas, the technician begins with estimates of the water requirement, month by month, and designs the system accordingly. In other areas, people display a knowledge of about how many acres should be in a pond to provide sufficient water to irrigate 100 acres, without the use of other types of watermeasurement concepts. Some respondent error was anticipated in the collection and summarization of mass data. In the absence of bias in the way the questions were asked, the high estimates tend to be counterbalanced by the low. One example of questionnaire bias might be in the interpretation of the question on amount of water used. Some cases were discovered where the respondent understood that only the amount of water applied in one irrigation was desired, whereas, the intent was to obtain the total amount applied during the census year. A possible bias in water-use data may have been introduced by the necessity to examine, review, and, if necessary, correct for certain extremes in respondent reports. The use of the computer allows for rapid calculations (for each farm record) of the average water use per acre, comparisons with minimum or maximum limits, and making corrections for those cases falling outside the limits. The problem arises because errors made by respondents reporting water use less than actual are difficult to detect. Since the actual application of even a fraction of an inch may be acceptable, if irrigation is used to supplement rainfall or when the supply of available water is limited, it has appeared necessary to use a very low reject limit. On the high side, acceptable maximum water application per acre for a given area can usually be estimated with greater precision. Thus, it is possible that a greater proportion of the reporting

errors resulting in estimates of high application rates were corrected than for those reporting low estimates. The same type of bias may also occur in crop production data.

SUMMARY OF OBSERVATIONS

Irrigated Farms

Historically the numbers of irrigated farms in the United States enumerated by the Census increased consistently over time through 1954 (chart 1). In the three censuses of 1959, 1964, and 1969 the numbers declined. A large part of the decline in numbers can be attributed to the generalized trend throughout agriculture toward larger farms. Changes in farm definition between the 1954 and 1959 census may have had some effect on the number of farms reporting irrigation. (See 1959 Census of Agriculture, Volume II, Introduction.)

The lower trend line in chart 1 represents the count of class 1-5 farms (farms with sales of \$2,500 and over). All 13 tables in the body of this chapter deal with class 1-5 farms except the first

CHART-1. Number of Irrigated Farms in the United States: 1900 to 1969



reporting irrigated cropland harvested and/or pasture irrigated.

three, which present data for all farms. The omission of class 6- part time, part retirement, and abnormal farms—from tables 4 through 13 is an omission of the smaller farms, for the most part.

Class 1-5 irrigated farms number 43,985 less than all irrigated farms. However, 41,094 of this difference is accounted for by the farms having less than 50 acres irrigated. Thus the differential in irrigated acreage covered by the class 1-5 group from the all farm group is much less than is indicated by the percentage that class 1-5 farms is of all farms (82.9 percent).

The 1969 Census of Agriculture enumerated 257,147 farms with irrigated land in the conterminous United States, Alaska, and Hawaii. Of the total number of irrigated farms, 213,162 or 82.9 percent were in class 1-5 (those having market value of sales of \$2,500 and over). In comparison with previous censuses, the total number of irrigated farms counted in 1969 was 16.5 percent less than the figure shown in the 1959 Census of Agriculture. The count of irrigated class 1-5 farms in 1969 also showed a decrease of 9.9 percent and 7.3 percent from the 1959 and 1964 censuses, respectively.

The States with the largest concentrations of irrigated farms, in proportion to the total number of farms, are located in the western half of the United States. The percentage distribution of irrigated farms among the 50 States is shown in chart 2. The 17 Western States and Louisiana account for 81.8 percent of all irrigated farms in the United States. Three of the Western States, California, Texas, and Nebraska, account for 47.1 percent of the irrigated farms in the western area. The Eastern States, Alaska, and Hawaii account for 18.2 percent of all irrigated farms with four of these states, Florida, Arkansas, North Carolina, and Kentucky, accounting for 48.7 percent in this eastern area.

The number of farms applying water for crop or pasture can vary considerably from year to year because of climatological and other uncontrollable conditions. The availability of water

Summary Table 1. Comparison of Numbers of Farms Irrigated Any Time During the January 1965 to December 1969 Period

| | Class 1-5 farms irrigating 1965-1969 | Class 1-5 farms irrigating 1969 | Percent not irrigating in 1969 | | Class 1-5 farms irrigating 1965-1969 | Class 1-5 farms irrigating 1969 | Percent not irrigating in 1969 |
|----------------|---|--|---|----------------|---|--|---|
| United States | 232,001 | 213,162 | 8.1 | Missouri | 1,508 | 1,214 | 19.5 |
| | | | | Nevada | 1,445 | 1,426 | 1.3 |
| California | 41,675 | 39,523 | 5,2 | Tennessee | 1,187 | 927 | 21.9 |
| Texas | 26,453 | 24,751 | 6.4 | Wisconsin | 1,161 | 1,034 | 10.9 |
| Nebraska | 19,797 | 19,053 | 3.8 | South Dakota | 1,134 | 978 | 13.8 |
| Idaho | 15,115 | 14,786 | 2.2 | | | | |
| Colorado | 13,031 | 12,738 | 2.3 | Pennsylvania | 1,090 | 745 | 31.7 |
| | | | | Ohio | 929 | 723 | 22.2 |
| Washington | 11,265 | 10,692 | 5.1 | South Carolina | 925 | 594 | 35.8 |
| Oregon, | 9,585 | 8,842 | 7.8 | Mississippi | 907 | 753 | 17.0 |
| Montana | 8,393 | 7,951 | 5.3 | Illinois | 876 | 681 | 22.3 |
| Utah | 7,230 | 7,055 | 2.4 | | | | |
| Florida | 7,050 | 6,280 | 10.9 | Massachusetts | 833 | 774 | 7.1 |
| | | | | Indiana | 640 | 428 | 33.1 |
| North Carolina | 7,029 | 4,810 | 31.6 | Minnesota | 597 | 447 | 25.1 |
| Kansas | 6,523 | 6,065 | 7.0 | Hawaii | 586 | 560 | 4.4 |
| Arkansas | 5,598 | 5,246 | 6.3 | Maryland | 585 | 496 | 15.2 |
| Kentucky | 4,747 | 3,878 | 18.3 | - | | | |
| Wyoming | 4,561 | 4,464 | 2.1 | North Dakota | 583 | 436 | 25.2 |
| | | | | Iowa | 429 | 212 | 50.6 |
| Georgia | 4,386 | 3,409 | 22.3 | Alabama | 356 | 245 | 31.2 |
| New Mexico | 4,031 | 3,904 | 3.2 | Connecticut | 301 | 229 | 23.9 |
| Louisiana | 4,025 | 3,789 | 5.9 | Delaware | 189 | 154 | 18.5 |
| Oklahoma | 3,906 | 3,495 | 10.5 | | | | |
| Arizona | 2,977 | 2,894 | 2.8 | Maine | 144 | 98 | 31.9 |
| | | | | West Virginia | 119 | 96 | 19.3 |
| Virgina | 2,741 | 1,916 | 30.1 | New Hampshire | 93 | 73 | 21.5 |
| Michigan | 2,059 | 1,719 | 16.5 | Rhode Island | 65 | 59 | 9.2 |
| New Jersey | 1,531 | 1,294 | 15.5 | Vermont | 60 | 34 | 43.3 |
| Now York | 1,529 | 1,171 | 23.4 | Alaska | 22 | 21 | 4.6 |

for irrigation depends on the quality and timing of precipitation, or on the fluctuation in ground water tables. Rain or lack of it during the growing season determines the need for artificial application of water. The East Atlantic Coastal States and the Midwestern States have the largest variation in year-to-year irrigation where the Mountain States consistently irrigate year after year. The 1969 census collected an additional item of information for class 1-5 farms by recording those that irrigated at some time from 1965 to December 1969, whether or not they irrigated in the census year, 1969. Summary table 1 presents this information and compares it with the number of farms reporting irrigation for the year 1969.

Irrigated Land in Farms

In contrast with the increasing trend in number of irrigated farms to 1954 followed by a down trend, each census since 1935 has marked an increase in acreage of land irrigated on farms in the United States (chart 3). The acreage of land irrigated in the entire United States has tripled since 1935. In the Western States plus Louisiana, the 1969 acreage irrigated was more than 2% times the 1935 acreage. In the Eastern States, irrigated acreage climbed almost 16-fold in this period.

The difference in rate and timing of development reflects the differences between climates in the East and West. In much of the arid West, irrigation has been prerequisite to cultivated crop production. While irrigation during short rainfall periods in the Eastern States can be a definite benefit to production, it is seldom required to prevent complete failure.

The 1969 Census of Agriculture shows that there were 39.1 million acres irrigated in the conterminous United States, Alaska, and Hawaii. In comparison with previous censuses, this represents an increase of 2.1 million acres irrigated, or 5.6 percent, since 1964 and an increase of 6.0 million acres irrigated, or 18.0 percent (excluding Alaska) since 1959. Most of the acreage increase in irrigated land has occurred in the Western States and Louisiana. This area has shown an increase of 1.7 million acres since 1964 and an increase of 4.3 million acres since 1959. However, in terms of percentage increases in irrigated land, the 30 Eastern States, Alaska, and Hawaii have shown the largest increase, an 11.2 percent increase since 1964 and an 87.3 percent increase since 1959.

Crops by Acres Irrigated

Chart 4 lists the most common crops grown on irrigated land, arrayed in descending order of the irrigated acreage of each crop in 1969. To a considerable extent, the crops which occupy the greater acreage on nonirrigated farms tend to be important also on irrigated land. There are marked differences, however. For instance, cropland pasture occupies more nonirrigated land than any individual crop for harvest, but ranks fifth in acreage of irrigated land. Wheat ranks third on nonirrigated lands but is eighth under irrigation.

The importance of irrigation to the production of the selected crops is more clearly shown by a listing of the percent of the total acreage of each crop which is grown under irrigation:







(The United States, 17 Western States, and Louisiana)

1930, acreage of irrigated crops; 1935, irrigated cropland harvested; 1940, acreage of irrigated cropland harvested and/or irrigated pasture; 1945 to 1969, acreage of irrigated land.

| Orchard | 57.5 | Hay crops cut green | 13.2 |
|------------------------|------|---------------------|------|
| Irish potatoes | 56.0 | Corn for silage | 12.9 |
| Alfalfa seed | 52.0 | Peanuts for nuts | 12.4 |
| All vegetables | 49.8 | Hay except alfalfa | 10.9 |
| Nursery and greenhouse | 49.2 | Sorghum for silage | 10.6 |
| , , | | Corn for grain | 6.4 |
| Cotton | 28.1 | All wheat | 4.5 |
| Sorghums for grains | 26.9 | Cropland pasture | 4.0 |
| Alfalfa hay | 22.1 | Soybeans for beans | 1.9 |
| Barley for grain | 17.3 | Oats for grain | 1.6 |
| Tobacco | 13.9 | All other crops | 22.1 |

In general, the crops which produce the greater monetary returns per acre appear near the top of this list, while the crops producing lower values per acre tend to be irrigated less frequently.

Crop Intensity Related to Irrigation

By definition, "cropping intensity" refers to the method of cultivating land designed to increase the productivity of a given area by the use of more labor, equipment, and materials. In general, the more "intensive" crops and the more "intensively" cultivated land require more labor, equipment, and materials and, in turn, result in a higher dollar value per acre return.

The section on definitions previously presented provides an estimate of the average value per acre of specified crops within each category. For tabulation purposes, each crop for which data were collected was designated as intensive, moderately intensive, or less intensive and grouped accordingly. The less intensive category accounts for 90 percent (237.9 million) of all crops harvested on all farms, whether irrigated or nonirrigated (summary table 2, and table 10 in the body of this chapter). The moderately intensive crops account for 6.4 percent, and the intensive crops, 3.6 percent of all crops harvested. When irrigated and nonirrigated farms are compared, it is noted that the intensive and moderately intensive crops become relatively more important on the farms which have adopted irrigation for all or part of the crops grown.

It should be noted that summary table 2 is intended to show the relationship between the presence of irrigation on farms and the intensity of land use. The harvested acres shown for irri-

Summary Table 2. Acreage and Percent of Land in Three Crop Intensity Groups on Irrigated and Nonirrigated Farms, With Sales of \$2,500 and Over: 1969

| | All crops harvested | | Intensive crops harvested | | Moderately intensive crops harvested | | Less intensive crops harvested | |
|---|------------------------|---------|------------------------------|---------|--|---------|--------------------------------------|---------|
| | Acres (1,000) | Percent | Acres (1,000) | Percent | Acres (1,000) | Percent | Acres (1,000) | Percent |
| United States: | | | | | | | | |
| Irrigated farms | 50,386 | 100.0 | 5,803 | 11.5 | 7.972 | 15.8 | 36.611 | 72.7 |
| Nonirrigated farms | 213,933 | 100.0 | 3,786 | 1.8 | 8,813 | 4.1 | 201,334 | 94.1 |
| 17 Western States and Louisiana: | | | | | | | | |
| Irrigated farms | 41,970 | 100.0 | 3.570 | 8.5 | 6,568 | 15.6 | 31.832 | 75.9 |
| Nonirrigated farms | 86,149 | 100.0 | 822 | 1.0 | 3,707 | 4.3 | 81,620 | 94.7 |
| 30 Eastern States, Alaska, and Hawaii: | | | | | | | | |
| Irrigated farms | 8,416 | 100.0 | 2,233 | 26.5 | 1.404 | 16.7 | 4.779 | 56.8 |
| Nonirrigated farms | 127,784 | 100.0 | 2,964 | 2.3 | 5,106 | 4.0 | 119,714 | 93.7 |

Note: Data are from table 10 in the body of this report.



CHART-4. Irrigated Cropland in Specified Crops and Pasture on Class 1-5 Farms: 1969

gated farms are not irrigated in entirety. Table 10 in the body of this chapter will show that about 75 percent of the crops harvested in the West are irrigated and about 37 percent in the It seems probable that the contrast between nonirri-East. gated farms and those having irrigation would be greater if a larger proportion of the farms using irrigation were wholly irrigated.

An example will illustrate the significance of shifts in cropping patterns made possible by the adoption of irrigation in dry areas of the West. It is emphasized that the following illustration is oversimplified, but it will demonstrate the principle. Using the 1969 cropping intensity pattern found in the 17 Western States and Louisiana as the basis for a cropping pattern for a 100-acre farm, an estimate can be made of the change in gross returns resulting from conversion to irrigated farming. Values per acre of the crop production for each intensity group are the approximate medians of the values presented in the

With these assumptions the following definitions section. before-and-after budget is prepared.

| | Acres of 100-acre | f crops e farm ¹ | Median value | Gros all | s value, crops |
|--------------------------------------|----------------------|--------------------------------|-----------------|-------------------|-------------------|
| | Non- irrigated | Irri- gated | per acre | Non- irrigated | Irri- gated |
| Intensive crops Moderately inten- | 1.0 | 8.5 | \$850 | \$850 | \$7,225 |
| sive crops | 4.3 | 15.6 | 175 | 752 | 2,730 |
| Less intensive crops | 94.7 | 75.9 | 60 | 5,682 | 4,554 |
| | 100.0 | 100.0 | | \$7,284 | \$14,509 |

¹Percent distribution of acreage among crop-intensity categories determined from data for 17 Western States and Louisiana in table 10 in the body of this volume.

Fertilization and Irrigation

Commercial fertilizer is used on 71 percent of the total crop acreage on irrigated farms in the eastern area compared with 56 percent on nonirrigated farms (summary table 3). In the western area, the fertilized percent figures are 62 on irrigated farms and 41 on nonirrigated farms. If fertilized acreage on irrigated farms in the West is compared with the irrigated acreage, over 87 percent of the irrigated crop area is fertilized. In the East, the acreage fertilized on irrigated farms is nearly double the acreage irrigated.

Summary Table 3. Acres Fertilized and Rate of Application on Irrigated and Nonirrigated Farms

| | | | Acres of crops fertilized | | Rate of application (pounds per acre) | | |
|-----------------------|-------------------------------------|--------------------------------|------------------------------|---------------------------------|---------------------------------------|------------------------|---------------------------|
| | Total acres of crop harvested | Acres of crops irrigated | f t <u>Total</u> | ercent of otal crop acres | All fertil- izer | Dry fertil- izer | Liquid fertil- izer |
| United States, total | 264.318.297 | 33,059,581 | 138,701,317 | 52,5 | 340 | 262 | 78 |
| Irrigated farms | 50.385.527 | 33,059,581 | 32,101,023 | 63.7 | 414 | 306 | 108 |
| Nonirrigated farms | 213,932,770 | - | 106,600,294 | 49.8 | 316 | 248 | 68 |
| 17 Western States and | | | | | | | |
| Louisiana | 128,118,643 | 29,875,008 | 61,714,391 | 48.2 | 228 | 154 | 74 |
| Irrigated farms | 41,969,523 | 29,875,008 | 26,104,094 | 62.2 | 332 | 220 | 112 |
| Nonirrigated farms | 86,149,120 | - | 35,610,297 | 41.3 | 150 | 106 | 44 |
| 30 Eastern States. | | | | | | | |
| Alaska and Hawaii | 136,199,654 | 3,184,573 | 76,986,926 | 56.5 | 428 | 348 | 80 |
| Irrigated farms | 8,416,004 | 3,184,573 | 5,996,929 | 71.3 | 772 | 688 | 84 |
| Nonirrigated farms | 127,783,650 | - | 70,989,997 | 55.6 | 400 | 320 | 80 |

The rate of application of fertilizer also varies by area and for irrigated and nonirrigated farms. The average rate of application for all class 1-5 farms in the United States was 340 pounds per acre fertilized. The rate varied from 428 pounds per acre in the East to 228 pounds per acre in the West. Comparison of application rates on irrigated versus nonirrigated farms showed an average of 414 pounds per acre on irrigated farms. These differences became much more pronounced when comparing irrigated and nonirrigated farms in the East versus those in the West. This is undoubtedly due to the availability of water and the cropping intensity patterns in the East versus the West.

Similar data on the fertilization of pasture as well as more geographical detail on the fertilization of crops will be found in table 9 in the body of this volume. The total acreage of pasture fertilized (10.2 million acres of cropland pasture and 6.4 million acres of other pasture) is about one-fifteenth as large as the crop acreage fertilized, and application rates are considerably lower.

Method of Irrigation Water Distribution

The method used to distribute or apply irrigation water also varies from one area to another. The four primary methods of applying irrigation water are furrows and ditches, flooding,

CHART-5. Acreage Irrigated by Specified Methods of Water Distribution on Irrigated Farms: 1969



sprinklers, and subirrigation. Of the four, furrows and ditches are used most extensively, particularly in the western United States. However, in the Eastern States, sprinkler irrigation is slightly more important in terms of acres irrigated.

Of the 38.2 million acres irrigated on class 1-5 farms, furrows and ditch irrigation was used on 19.2 million acres, or 50.1 percent (chart 5). Flooding was used on 11.9 million acres (31.1 percent), sprinklers on 7.2 million acres (18.2 percent) and subirrigation on 0.6 million acres (1.6 percent). The sum of the acreage irrigated by each method exceeds the total acres irrigated because in some areas more than one method was used to irrigate the same acreage. However, water was applied to most irrigated acreage by only one method. Of the total acreage irrigated, 27.8 million acres, or 72.9 percent were irrigated by a single method. Of the acreage irrigated by a single method, 14.2 million acres (50.9 percent) were irrigated by furrows and ditches, 8.4 million acres (30.3 percent) by flooding, 4.9 million acres (17.7 percent) by sprinklers, and 0.3 million acres (1.2 percent) by subirrigation.

Summary Table 4. Average Acre-Feet of Water Applied, by Area and Method of Application

Average acre-feet of water applied per

| | United States | 17 Western States and Louisiana | 30 Eastern States, Alaska and Hawaii |
|---------------------|---------------|---------------------------------------|--|
| Furrows and ditches | 2,06 | 2.13 | .78 |
| Flooding | 2,26 | 2.36 | 1.40 |
| Sprinklers | 1.39 | 1.64 | , 59 |
| Subirrigation | 1,39 | 2.16 | .91 |

The methods used to apply irrigation water also have a definite effect on the quantity of water applied per acre (summary table 4). Water use was highest on farms utilizing flood irrigation. These farms reported an average of 2.26 acre-feet of water applied per acre. At the U.S. level, sprinkler and subirrigation showed the lowest water use with equal averages of 1.39 acre-feet per acre. However, there were distinct differences in water use in the West versus East.

Crop Production on Irrigated and Nonirrigated Land

Since crop production is one of the leading indicators of the effects of irrigation, data are provided for average yield for selected crops harvested from irrigated and nonirrigated land: Table 11 presents data for farms reporting, acres harvested of selected crops, and the average yield per acre for irrigated and nonirrigated land. The selected crops were tabulated as wholly irrigated, nonirrigated, and partly irrigated. The crop was classified "wholly irrigated" if the farm reported all acres harvested of the specified crop as being irrigated. Likewise, a crop was tabulated as "nonirrigated" if the farm reported acreage harvested for the crop but none of the acreage was reported irrigated. The "partly irrigated" category includes the crop acreage from those farms where only part of acres harvested of the specified crop was reported irrigated. The average yield per acre was computed for the acres harvested of each specified crop for each category. In most cases, particularly in the western part of the United States, the differences in average yields on wholly irrigated and nonirrigated acreage were striking.

To provide an overall view of the effect of irrigation, data are presented in summary table 5 concerning average yield for selected crops with respective crop yield indexes for the 17 Western States and Louisiana and for the 30 Eastern States, Alaska, and Hawaii. In computing the indexes, the U.S. average yield per acre for each specified crop was used as the base figure and set equal to 100. The index of average yields was then computed for the average yield of that portion of the crops that was wholly irrigated and the portion that was not irrigated for each of the two areas.

Summary Table 5. Index of Average Yield for Specified Crops Harvested From Wholly Irrigated Land and Nonirrigated Land When U.S. Average Yield=100

| | Average yield per acre-United States | | Index for 17 Western States and Louisiana | | 30 Eastern States, Alaska, and Hawaii | |
|----------------------------------|--|-------|---|---------------------------|--|----------------------|
| | Average yield | Index | Crop wholly irrigated | Crop non- irrigated | Crop wholly irrigated | Crop nonirrigated |
| Alfalfa haytons | 2.82 | 100 | 139 | 73 | 119 | 102 |
| Corn for grainbushels | 85.9 | 100 | 128 | 69 | 99 | 102 |
| Corn for silage tons, green wt., | 12.47 | 100 | 140 | 60 | 111 | 105 |
| Sorghum for grainbushels | 53.0 | 100 | 149 | 84 | 104 | 102 |
| Winter wheatbushels | 29.8 | 100 | 148 | 93 | 115 | 121 |
| Spring wheatbushels | 26.8 | 100 | 183 | 96 | 108 | 112 |
| Barleybushels | 44.2 | 100 | 139 | 89 | 112 | 110 |
| Oatsbushels | 53.8 | 100 | 109 | 90 | 141 | 107 |
| Soybeans for beansbushels | 27.2 | 100 | 117 | 82 | 96 | 102 |
| Dry field beans100-1b. bags | 13.2 | 100 | 132 | 45 | 124 | 96 |
| Alfalfa scedpounds | 222 | 100 | 155 | 42 | 64 | 29 |
| Cottonbales | 0.91 | 100 | 148 | 58 | 137 | 110 |
| Tobaccopounds | 1,881 | 100 | 55 | 39 | 103 | 100 |
| Irish potatoescwt | 216.7 | 100 | 116 | 66 | 106 | 87 |
| Sugar beets for sugartons | 17.97 | 100 | 107 | 76 | 93 | 77 |
| All vegetablesdollars | 388,83 | 100 | 146 | 37 | 169 | 52 |
| Fruits, nuts, berriesdollars | 413.62 | 100 | 129 | 46 | 89 | 75 |

It is quite obvious that irrigation has a much greater effect on average production in the West versus the East. In the West, the mean index for wholly irrigated production is 132 and for nonirrigated production is 67. This indicates that production for the specified crops which are wholly irrigated is generally 32 percent greater than the U.S. average. Nonirrigated crop production, on the other hand, is 33 percent less. The mean index for wholly irrigated production in the East is 111 and for nonirrigated production is 93 when compared to the U.S. average. Therefore, wholly irrigated crop production for the specified crops is generally 11 percent greater than the U.S. average for all crops and nonirrigated production is only 7 percent less. However, as can be seen, the percentage indexes vary considerably by crop and area.

Another measure of the effect of irrigation is the value of products produced on irrigated farms versus nonirrigated farms. In 1969, the total market value of products sold from all farms amounted to \$45.6 billion. Class 1-5 farms accounted for \$44.5 billion, or 97.6 percent of the total value of all farm products. Table 12 in the body of this chapter provides detailed information for value of products sold from nonirrigated farms and from irrigated farms by percent of cropland irrigated, as well as selected expenditures for the same groups. The data in summary table 6 presents the highlights.

Of the \$44.5 billion of total products sold from class 1-5 farms, irrigated farms accounted for \$11.4 billion, or 25.6 percent of the total. This \$11.4 billion worth of products results from only 12.3 percent of class 1-5 farms, 17.9 percent of cropland, and 22.8 percent of all land in class 1-5 farms.

These figures also vary considerably from East to West. The 17 Western States and Louisiana account for 43.1 percent of the \$44.5 billion worth of farm products sold, while the other States account for 56.9 percent. Thus, the West accounted for \$19.2 billion worth of farm products and, of this amount, 47.1 percent came from irrigated farms versus the East where irrigated farms account for only 9.4 percent of the \$25.3 billion of farm products sold.

Summary Table 6. Percentage of Selected Items on Irrigated and Nonirrigated Class 1-5 Farms: 1969

| | | Total acres | Ail land other than croniand | Total production expenses | Total value products sold |
|----------------------------|-----------|-------------|---------------------------------------|---------------------------------|---------------------------------|
| | Farms | (1,000) | (1,000) | (1,000) | (1,000) |
| United States, Total | 1,733,683 | 417,430 | 500,882 | \$36,247,455 | \$44,521,258 |
| Nonirrigated farms | 1,520,521 | 342,686 | 366,685 | 26,334,994 | 33,107,117 |
| Percent of total | 87.7 | 82.1 | 73.2 | 72.7 | 74.4 |
| Irrigated farms | 213,162 | 74,745 | 134,197 | 9,912,461 | 11,414,141 |
| Percent of total | 12.3 | 17.9 | 26.8 | 27.3 | 25.6 |
| 17 Western States and | | | | | |
| Louisiana, total | 589,745 | 217,928 | 398,047 | 16,548,277 | 19,171,394 |
| Percent of United States | 34.0 | 52.2 | 79.5 | 45.7 | 43.1 |
| Nonirrigated farms | 416,903 | 153,749 | 271,795 | 8,592,321 | 10,145,377 |
| Percent of 18 States | 70.7 | 70.6 | 68.3 | 51.9 | 52.9 |
| Irrigated farms | 172,842 | 64,179 | 126,252 | 7,955,956 | 9,026,018 |
| Percent of 18 States | 29,3 | 29.4 | 31.7 | 48.1 | 47.1 |
| 30 Eastern States, Alaska, | | | | | |
| and Hawaii, total | 1,143,938 | 199,502 | 102,835 | 19,699,178 | 25,349,864 |
| Percent of United States | 66.0 | 47.8 | 20.5 | 54.3 | 56.9 |
| Nonirrigated farms | 1,103,618 | 188,936 | 94,890 | 17,742,673 | 22,961,741 |
| Percent of 30 States | 96.5 | 94.7 | 92.3 | 90.1 | 90.6 |
| Irrigated farms | 40,320 | 10,566 | 7,945 | 1,956,505 | 2,388,123 |
| Percent of 30 States | 3.5 | 5.3 | 7.7 | 9.9 | 9.4 |