U.S. CENSUS OF AGRICULTURE : 1959 Final Report—Vol. V—Part 2-Special Reports

> SOURCE OF WATER METHOD OF APPLICATION TYPE OF POWER • ACRES IRRIGATED FREQUENCY OF APPLICATION

Irrigation in Humid Areas

SPECIAL REPORTS

Prepared under the supervision of RAY HURLEY, Chief Agriculture Division



U.S. DEPARTMENT OF COMMERCE Luther H. Hodges, Secretary BUREAU OF THE CENSUS Richard M. Scammon, Director (From May 1, 1961) Robert W. Burgess, Director (To March 3, 1961)





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Statistics in this report supersede figures shown in Series AC59-1 and AC59-2, Preliminary Reports

Library of Congress Catalog Card Number: A60-9482

SUGGESTED CITATION

U.S. Bureau of the Census. U.S. Census of Agriculture: 1959. Vol. V, Part 2 Irrigation in Humid Areas U.S. Government Printing Office, Washington, D.C., 1960

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., or any of the Field Offices of the Department of Commerce. Price \$1

PREFACE

Volume V, Part 2, "1960 Survey of Irrigation in Humid Areas" presents the results of the special 1960 survey conducted for the farmers in 30 eastern States who reported irrigation in the 1959 Census of Agriculture. Most of the information was collected by mail although a few reports were obtained by telephone and personal enumeration.

The 1960 Survey of Irrigation was taken in conformity with the Act of Congress of August 31, 1954 (amended August 1957), which codified Title 13, United States Code.

The planning, compilation of statistics, and the preparation of this report were under the supervision of Ray Hurley, Chief, Agriculture Division, assisted by Henry L. DeGraff, Irrigation Economist. The text was written by Warder B. Jenkins, Assistant Chief. Assistance in the compilation and publication of the statistics was given by Orvin L. Wilhite, Assistant Chief; Lois G. Miller; Bennie L. Sharp; and Helen D. Turner. The field followup enumeration was conducted under the supervision of Jefferson D. McPike, Chief, Field Division. The maps were prepared under the supervision of William T. Fay, Chief, Geography Division.

December 1961

III

UNITED STATES CENSUS OF AGRICULTURE: 1959 FINAL REPORTS

Volume I—Counties—A separate part for each State. Statistics on number of farms; farm characteristics; acreage in farms; cropland and other uses of land; land-use practices; irrigation; farm facilities and equipment; farm labor; farm expenditures; use of commercial fertilizer; number and kind of livestock; acres and production of crops; value of farm products; characteristics of commercial farms, farms classified by tenure, by size, type, and economic class; and comparative data from the 1954 Census of Agriculture.

Volume I is published in 54 parts as follows:

Part	State or States	Part	State or States	Part	State or States
$ \begin{array}{c} 1\\2\\3\\4\\5\\6\\7\\8\\9\\10\\11\\12\\13\\14\\15\\16\\17\\18\end{array} $	New England States: Maine. New Hampshire. Vermont. Massachusetts. Rhode Island. Connecticut. Middle Atlantic States: New York. New Jersey. Pennsylvania. East North Central: Ohio. Indiana. Illinois. Michigan. Wisconsin. West North Central: Minnesota. Iowa. Missouri. North Dakota.	$ \begin{array}{r} 19\\ 20\\ 21\\ 22\\ 23\\ 24\\ 25\\ 26\\ 27\\ 28\\ 29\\ 300\\ 311\\ 32\\ 33\\ 34\\ 35\\ 36\\ 37\\ \end{array} $	West North Central—Continued South Dakota. Nebraska. Kansas. South Atlantic: Delaware. Maryland. Virginia. West Virginia. North Carolina. South Carolina. Georgia. Florida. East South Central: Kentucky. Tennessee. Alabama. Mississippi. West South Central: Arkansas. Louisiana. Oklahoma. Texas.	$\begin{array}{r} 38\\ 39\\ 40\\ 41\\ 42\\ 43\\ 44\\ 45\\ 46\\ 47\\ 48\\ 49\\ 50\\ 51\\ 52\\ 53\\ 54\\ \end{array}$	Mountain: Montana. Idaho. Wyoming. Colorado. New Mexico. Arizona. Utah. Nevada. Pacific: Washington. Oregon. California. Alaska. Hawaii Other Areas: American Samoa. Guam. Puerto Rico. Virgin Islands.
				1	

Volume II—General Report.—Statistics by Subjects, United States Census of Agriculture, 1959. Summary data and analyses of the data by States, for geographic divisions, and for the United States, by subjects, as illustrated by the chapter titles listed below:

Chapter	Title	Chapter	Title
I II IV V VI	Farms and Land in Farms. Age, Residence, Years on Farm, Work Off Farm. Farm Facilities, Farm Equipment. Farm Labor, Use of Fertilizer, Farm Expenditures, and Cash Rent. Size of Farm. Livestock and Livestock Products.	VII VIII IX XI XII XII	Field Crops and Vegetables. Fruits and Nuts, Horticultural Specialties, Forest Prod- ucts. Value of Farm Products. Color, Race, and Tenure of Farm Operator. Economic Class of Farm. Type of Farm.

Volume III—Irrigation of Agricultural Lands. Western States (Dry Areas)—Data by States for drainage basins and a summary for the area, including number and types of irrigation organizations, source of water, expenditures for works and equipment since 1950, water used and acres served for irrigation purposes.

Volume IV—Drainage of Agricultural Lands. Data by States on land in drainage organizations, number and types of organizations, cost of drainage and drainage works. Volume V—Special Reports, Part 1.—Horticultural Specialties. Statistics by States and a summary for the United States presenting number and kinds of operations; gross receipts and/or gross sales; sales of nursery products, flower seed, vegetables grown under glass, and propagated mushrooms; number of containergrown plants; inventory products; sales of bulb crops; employment; structures and equipment.

Titles of additional parts of this volume are not available as this report goes to press.

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INTRODUCTION

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INTRODUCTION IRRIGATION IN HUMID AREAS

Introduction .- Irrigation of agricultural lands is usually associated with a practice widely used in crop production in the Western States. In that broad geographic area, more than onehalf of the farms use water for irrigation and more than one-half of the cropland receives some water in excess of natural precipitation. However, in the other States, the precipitation is not always dependable either in total amount or in distribution during the growing season. In parts of the Great Plains, crops are produced under relatively high-risk weather conditions. Even when summer fallow is practiced, yields are often low or there may be total failure. In these States, the irrigated area has been increasing rapidly during recent years and the supplemental water obtained largely from underground aquifers or from recently built aboveground storage reservoirs. In the States east of the Great Plains, irrigation has become a more widely accepted practice, particularly in the production of high-income-per-acre crops or of other crops where water can be applied at a cost that is below expected gains in income.

Since interest in irrigation statistics is no longer confined to developments in western areas, the collection of some information in regard to supplemental water use by farmers on a nationwide basis has been undertaken in connection with the two most recent censuses of agriculture. The legislation which provides for Census collection of agricultural statistics specifies that a census of irrigation shall be taken at 10-year intervals in conjunction with the census of agriculture. Some of the data regarding irrigation have been collected for the decennial census from irrigation organizations and some from farm operators. Outside of the Western States, irrigation organizations do not have an important role in providing water for irrigation purposes and, therefore, in other than Western States all of the data regarding irrigation must be secured from farm operators.

Increased and fuller mechanization of agriculture has enabled farmers to enlarge their landholdings. Commercial farm producers may attain higher total output not only through the use of more land but also by adding increments of other inputs. The installation of a new farming practice such as irrigation, or the use of more fertilizer, can have the same effect on agricultural output of an individual producer as an enlargement in the area of the land he operates.

There are other variables which influence the rate of acceptance and adoption of irrigation. The variability in the rainfall pattern within a given area, as between years or even within the growing season, may determine the number of farmers irrigating in one year as compared with another. Crops such as rice, cranberries, and greenhouse products almost universally require supplemental supplies of water for their production. The detrimental effect of drought periods of uncertain frequency, duration, and time of occurrence has caused other crop and livestock producers to look upon irrigation as a form of production insurance even in humid areas. Under farm programs associated with acreage reduction, many producers strive for higher yields per acre. When acreage is restricted, a likely way a farmer may increase his return is by increasing yields per acre. Increased applications of fertilizer and more dense planting of crops usually make irrigation more profitable. Often the quality of a crop can be improved by irrigation which, with an increase in yield,

may provide sufficient additional income to more than match the added cost of applying water. Irrigation provides other benefits also. Within certain ranges of temperature, spray irrigation can be and is used to prevent frost damage. Irrigation water can be utilized for fertilizer distribution. The introduction of lightweight portable pipe has hastened the adoption of irrigation through lowered costs of system installation and of its annual maintenance and operation. Sprinkler irrigation has several advantages. Land leveling is not necessary. Also, if because of crop rotation or other farming practices the crop selected to receive an additional supply of water is grown in a different field from year to year, the use of movable pipe eliminates the need for and the cost of maintenance of supply ditches.

Farm ponds and larger areas of impoundments, whether constructed by individuals or by joint action of several individuals; stream flows; and wells have been increasingly utilized for growing truck and vegetable crops and for berry and tree fruit production. Pastures, particularly for dairy herds, have received applications of supplemental supplies of water. By irrigation, pasture-carrying capacity is increased, thereby, through both the extension of the grazing period and the production of more forage throughout the grazing period. Tobacco, cotton, com, and soybeans are among the important field crops that have been irrigated.

The use of water for irrigation places agriculture in competition with the growing needs of the human population and of industry for existing water supplies. Policy decisions in respect to the use of water for irrigation and related subjects such as water rights, water storage, flood prevention, drainage, recreational activities, and water pollution are currently under review by States and communities concerned with the supplies of and projected needs for water. The recent surveys of irrigation in humid areas not only provide information as to new production methods in agriculture but meet some of the needs for data as to current developments in water use as well as to a limited extent in water storage.

Scope of This Report.--Volume III of the 1959 Census of Agriculture Reports presents statistics regarding the irrigation of lands used for agriculture in 18 Western States and Hawaii. This part 2, volume V, presents all the data that will be published from a special survey conducted in the fall of 1960 covering the irrigation of farmlands in the more easterly States of the United States. The 30 States in this survey include all States from Minnesota southward to the Gulf of Mexico, with the exception of Louisiana, and eastward of that tier of States. For this report this group of 30 States has been termed the "humid areas." Volume III, the complement of this report, presents irrigation statistics for Louisiana and for those States which are westward of the humid areas, and Hawaii but excluding Alaska. For brevity, reference is sometimes made herein to the group of 18 Westem States as the "Irrigation States."

A listing of the names of all irrigators of farmlands was obtained from the agricultural questionnaire filled for all farms in the fall of 1959. The survey statistics, while they relate to 1960, are confined to the lands operated by farm operators reporting land irrigated in 1959, or their successors. Through the inclusion in the 1960 survey of all 1959 farm operators reporting irrigation, and only those, a limited amount of data is available for the farms with irrigation in 1959 but not in 1960. (Data for that group of farms are given in State Table 1.) No effort was made to identify, nor to secure information for any farm with irrigated land in 1960 but with no irrigated land reported for the 1959 Census of Agriculture. Because of the variation in rainfall, it cannot be stated with certainty whether the number of farms with irrigated land in 1959, but without irrigated land in 1960, would equal the number with irrigated land in 1960, but not in 1959. Eight maps are presented to show the relationship of rainfall in June, July, August, and September for the years 1959 and 1960 to the average rainfall over a span of years for the critical months in crop growth.

Following the 1954 Census of Agriculture, a similar survey of irrigation of farmlands was conducted, at the close of 1955, in 28 eastern States. For comparative purposes, some of the data collected in that survey are presented in this report.

Totals are presented in this part of volume V for States and selected counties.

Volumes I and II of the 1959 Census of Agriculture Reports present for both counties and States additional data on irrigation from the general enumeration of all farms.

Legal Basis for Survey of Irrigation in Humid Areas.—The 1960 Survey of Irrigation in Humid Areas was authorized by an Act of Congress. "Title 13, United States Code—Census," codified in August 1954, and amended in August 1957 and September 1960, is now the legal basis for censuses of agriculture and other censuses and surveys conducted by the Bureau of the Census. Section 142 paragraph (b), made provision for a census of irrigation and paragraph 181 made provision for the survey. These sections read in part as follows:

"142. Agriculture, irrigation, and drainage.

- a. The Secretary shall, beginning in the month of October 1959, and in the same month of every fifth year thereafter, take a census of agriculture, provided that the censuses directed to be taken in October 1959 and each tenth year thereafter, may, when and where deemed advisable by the Secretary, be taken instead in conjunction with the censuses provided in section 141 of this title.
- b. The Secretary shall, in conjunction with the census of agriculture directed to be taken in October 1959 and each tenth year thereafter, take a census of irrigation and drainage.
- 181. Surveys.

The Secretary may make surveys deemed necessary to furnish annual and other interim current data on the subjects covered by the censuses provided for in this title."

History of Census Enumeration of Irrigation.-One or more inquiries relating to irrigation of farm and ranch lands have been included in each successive census of agriculture since 1890, with one exception, viz, 1925. These inquiries were directed to the farm operator. Data from the inquiries carried in censuses of agriculture are shown herein for only the last two censuses. A special survey of irrigation in humid-area States was made in the year following both the 1954 and 1959 Censuses of Agriculture.

Beginning in 1910, a special decennial census of irrigation has been taken in the States in which irrigation was most extensively practiced. The States included in the Irrigation Censuses in 1910, 1920, and 1930, were the 17 Western States, Arkansas, and Louisiana. Florida was included in 1940 and 1950. The 17 Western States, Louisiana, and Hawaii were included in the 1959 Census of Irrigation. In these decennial censuses of irrigation, the inquiries were directed to irrigation organizations. Some comparative historical statistics are given from the irrigation censuses in volume III of the reports of the 1959 Census of Agriculture.

A joint resolution of Congress, approved June 30, 1902, provided for the collection of data on irrigation for the crop year 1902. Questionnaires were mailed to all the irrigators reported in the 1900 Census of Agriculture and to the officials of important irrigation canal companies. The data obtained were tabulated by drainage basins in order, so it was reported, that a better knowledge may be had of the extent to which the waters in each drainage basin were being used. (See Census Bulletin 16 "Irrigation in the United States: 1902," published in 1904.)

ENUMERATION FORMS AND PROCEDURES

Questionnaires.—The data in respect to irrigation, obtained directly from farm operators, have been compiled from the agriculture questionnaires for the censuses of agriculture when all farms are visited and from a subsequent special questionnaire required for farm operators reporting irrigation in the general census of agriculture. Data collected from irrigation organizations have been obtained, largely, by special enumerators independently of the general census of agriculture.

A facsimile of the survey questionnaire, designated "I-20, 1960 Survey of Irrigation in Humid Areas" appears in the appendix. Since the 1960 and 1955 surveys were to be conducted by mail, the number of questions was necessarily limited to key items relating to irrigation in the humid areas. The experience and procedures used for the 1955 Survey of Irrigation in Humid Areas influenced greatly the preparation of the questionnaire for the 1960 Survey. Some items which had been included in the 1955 Survey were eliminated from the 1960 Survey and other items were added. Data on the cost of irrigation systems included in the 1955 Survey, but for which many farm operators could not furnish information, were omitted from the 1960 Survey. On the other hand, additional information relating to sources of water, the area irrigated by each method of water application, and the number of acres of and the number of times specified crops were irrigated was obtained to provide a basis for estimating the quantity of water used for irrigation.

Two special committees were consulted in the preparation for the 1960 Survey of Irrigation in Humid Areas. Both committees were given the opportunity to review the general plan as to how the survey was to be conducted, and the proposed inquiries. One committee, a Special Federal Agency Committee, for the 1959 Censuses of Irrigation and Drainage, comprised representatives of the following agencies: Agricultural Conservation Program Service, Agricultural Research Service, Rural Electrification Administration, and Soil Conservation Service of the U.S. Department of Agriculture; Bureau of Indian Affairs and Bureau of Reclamation of the U.S. Department of the Interior; and the Bureau of the Census. The second committee, the Special Advisory Committee for the 1959 Census of Agriculture, reviewed the later stages of the planning. This committee consisted of one representative from each of the following: Agricultural Publishers Association, American Association of Land Grant Colleges and State Universities, American Farm Bureau Federation, American Farm Economic Association, American Statistical Association, Farm Equipment Institute, National Association of Commissioners, Secretaries, and Directors of Agriculture, National Council of Farmer Cooperatives, National Farmers' Union, National Grange, Rural Sociological Society, and the U.S. Department of Agriculture. A representative of the Bureau of the Budget was in attendance at meetings of this committee.

INTRODUCTION

The 1959 Census of Agriculture questionnaire, from which the list of farm operators with land irrigated was obtained for the 1960 Survey, contained a single inquiry relating to irrigation for those States which were included in the 1960 Survey. The 1959 inquiry was as follows: The questionnaire for the 1960 Survey of Irrigation in Humid Areas was designed, in part, to obtain data similar to those obtained in the Irrigation States from farm operators, for the 1959 Census of Agriculture. The inquiries for the Irrigation States were not used in the humid areas partly because the questions

Section V.—IRRIGATION	
213. Of the total land in this place (reported in question 203), how many acres were irrigated this year?	X

This inquiry was on the agriculture questionnaire used in the following 30 States:

Maine	Indiana	West Virginia
New Hampshire	Illinois	North Carolina
Vermont	Michigan	South Carolina
Rhode Island	Wisconsin	Georgia
Massachusetts	Minnesota	Florida
Connecticut	Iowa	Kentucky
New York	Missouri	Tennessee
New Jersev	Delaware	Alabama
Pennsylvania	Maryland	Mississippi
Ohio	Virginia	Arkansas

Only a limited part of the State data collected by the questionnaire for the States listed above is included in this report. Data for all counties with reports for irrigation appear in the State reports comprising volume I of the reports of the 1959 Census of Agriculture.

In all other States in the conterminous United States and in Hawaii, the questionnaire for the 1959 Census of Agriculture contained several inquiries regarding irrigation, as follows: would be applicable to such a small proportion of the farms or farm operators. Furthermore, a special survey made, at a later time, would permit the obtaining of useful data in respect to the year in which irrigation was first practiced, source of irrigation water, method of applying water, type of power utilized in the application of water, how many times a crop was irrigated, constructed reservoirs, and other purposes served by the use of irrigation water.

The questionnaires used in the 1959 Census of Irrigation (for the 19 Irrigation States) covering operations of irrigation organizations, are reproduced in the appendix of volume III of the reports for the 1959 Census of Agriculture. The data obtained by their use appear in volume III.

List of Farmers With Irrigation in 1959.—After the editing of the 1959 Census of Agriculture questionnaires had been completed, all questionnaires for the 30 States were examined to locate reports of farm operators with irrigated acreage in 1959. A transcription card (see exhibit 2 in the appendix) was prepared with selected data about the operator and the farm, as each questionnaire with irrigated land was identified. The number of cards and the total of the irrigated acreage were reconciled in

Section V.—IRRIGATION					
213. Of the total land in this place (reported in question 203), how many acres were irrigated this year? None Acres (If "None," mark X and skip to question [218].)					
214. How many acres in this place were irrigated by sprinklers this year?	-				
 215. From how many acres of irrigated land were crops harvested <i>this year</i>? (Be sure to include all irrigated land from which hay was cut and all irrigated land in both bearing and nonbearing fruit and nut crops and irrigated land from which volunteer crops were harvested.) (If "None." mark X and skip to question [217].) 					
216. What part of the land from which crops were harvested this year was irrigated?					
Name of crop irrigated? Acres irrigated? Name of crop irrigated? Acres irrigated?					
(1) (3)					
(2) (4)					
 (a) From a well (pumped or flowing) or spring directly by this farm or from another farm?					
(c) From a mutual or cooperative water or ditch company, irrigation district, or other irrigation organization? (Give name below.)					
Name Name L					

most States with the number of farms and the irrigated acreage tabulated for the 1959 Census of Agriculture. These transcription cards not only provided the names and addresses of respondents but also served as a control record for the enumeration for the 1960 Survey of Irrigation in Humid Areas.

The Enumeration.--The survey questionnaires were mailed in December 1960 to each farm operator in the 30 Eastern States for whom irrigated acreage was reported in the 1959 Census of Agriculture. The mailed questionnaires were accompanied by a letter stating the purpose of the survey and asking cooperation in filling and returning the questionnaire.

Three subsequent mailings were made, as necessary, to nonrespondents, at approximately three-week intervals. Enumerators were employed to obtain information from nonrespondents either by telephone, or by personal visit, if the operator had a relatively large acreage of irrigated land in 1959. The number of 1959 irrigated acres which determined whether or not a nonrespondent farm operator would be contacted, by telephone or in person, varied by States, as follows:

Georgia, North Carolina, and	
South Carolina	acres
All other States75	acres

Questionnaires were obtained for farm operators who reported 96.5 percent of the irrigated acreage for the 1959 Census of Agriculture.

To make the 1960 Survey more complete, as well as to increase the usefulness of the data, estimates were made for the remaining nonrespondents after the field followup enumeration had been completed. The estimates were made for individual farm operators on the basis of the data reported for the 1959 Cen sus of Agriculture, and also the 1960 reports for the special survey for farms in the same county. The proportion of the 1959 irrigated acreage for which reports were estimated is shown by States in State Table 1.

Editing and Coding of Questionnaires .- The transcription card containing an identification number and the name and address of the farm operator was used to insure the completion of the enumeration and for reference purposes during the editing process. As the question naires were received, the corresponding transcription card was attached to the questionnaire and remained there until editing was completed. This procedure eliminated the acceptance of duplicate questionnaires and permitted the measuring of the completeness of the enumeration at any time. Each questionnaire was individually edited and coded before the information was transferred to punchcards for tabulation. Each questionnaire was examined by clerks, in accordance with written instructions, for errors, omissions, and inconsistencies. Among the specific items subjected to consistency checks were the following: (a) irrigated acreage compared with total acreage in the farm; (b) the reporting of constructed reservoirs when the source of water indicated that reservoirs were necessary; (c) acres irrigated by method of irrigation, as compared with the total acres irrigated; and (d) the acres of crops reported irrigated as compared with the total acres irrigated. Obvious errors in calculations and misplaced entries were corrected. Questionnaires containing major inconsistencies and omissions were reviewed by a member of the technical staff and, depending on the magnitude of the data involved, the changes were made on the basis of information reported for other farms of similar type in the area, or on the basis of additional information received in response to letters to the farm operators.

During the editing, estimates were prepared for each nonrespondent as follows:

Acres in placeFrom 1959 Census of Agriculture Tenure codeFrom 1959 Census of Agriculture Acres irrigatedFrom 1959 Census of Agriculture Year irrigation began Not estimated Constructed reservoirs ... 1 supplied provided water source indicated a need for a constructed reservoir Source of water.....Determined from reports for farms in same area Method of irrigation Determined from reports for farms in same area Type of power.....Not estimated Crops irrigated and number of times irrigated 1959 crops and farms in same area Supplemental uses of irrigationNot estimated

The 4,600 nonrespondents, for whom 1960 estimates were made, represented 15.4 percent of the total number of 1960 farms with irrigation in the Humid Area but the estimate for their 1960 irrigated acreage represented only 3.4 percent of the total irrigated acreage for the same 30-State area. The estimates for these farms probably do not have a large margin of error either in the number of farms reporting or in the totals for irrigated acreage or for other items of information to which the estimates **are** confined.

All farms were coded by size of farm on the basis of total acreage operated and by tenure of operator. Crops irrigated, for which there were no specific inquiries on the questionnaire, were coded also.

Tabulation of Data.—After the questionnaires were edited and coded, the information was punched on tabulating cards. These punched cards were checked mechanically and those cards which still lacked necessary information, or which contained previously undetected or unchanged inconsistent or impossible data were listed for further checking and review. The listings were examined and, as necessary, the cards were corrected. The data were tabulated after the cards for a particular State were considered satisfactory. All tabulations were examined for reasonableness and internal consistency. Corrections on the basis of further review and reappraisal of the original reports and verification of the editing, coding, and punching, were made when necessary.

PRESENTATION OF STATISTICS

Organization of Tables .- Data obtained in the 1960 Survey of Irrigation in Humid Areas are presented in 12 State tables containing totals for individual States and for the 30 States as a group. These data are complemented with totals for selected items, for selected counties, in a county table. Selected counties comprise those counties in which 1,000 or more acres of irrigated land were reported in the 1959 Census of Agriculture or the 1960 Survey. In 6 States, Illinois, Kentucky, New Hampshire, Rhode Island, Vermont, and West Virginia, there were no counties with 1,000 or more acres of irrigated land. However, County Table 1 is presented for these 6 States so as to provide State data by crop groups corresponding to the data for the other 24 States. In County Table 1 the totals for the listed counties will not equal the total given for the State as figures for the group of counties with less than 1,000 acres of irrigated land, in both 1959 and 1960, are not shown. When comparative data are presented, from the earlier census or survey, totals are also given for the 28 States included in both surveys. The table titles, as listed in the Table of Contents, are descriptive of the tabular material presented in each.

Comparability of Data.—Since State totals relating to irrigation of farmlands are presented for a limited number of items for two census years (1959 and 1954) and for the two subsequent special surveys (1960 and 1955), it is possible to compare census data with census data, survey data with survey data, and census data for one year with survey data for the following year. State Table 1 provides a comparison of some 1959 Census data with 1960 Survey data and State Table 2 provides additional comparisons for both periods.

The figures for irrigation, presented for the 1959 and 1954 Censuses of Agriculture, were obtained by the same procedures. They are comparable with the exception of differences resulting from the carrying out of processing instructions in regard to irrigated acreage reported in fractions of less than one acre. In 1954, a report of a fractional part of an acre, when unaccompanied with an integral number, was increased to a whole integer and the report of irrigation was thus retained. In 1959, farms with less than one acre irrigated were omitted from the count of farms with irrigation. To a limited extent, the 1959 number of farms with irrigation may be understated when compared with the number for 1954. However, the difference in processing procedures had little effect on the comparability of irrigated acreage for the two census years.

The data for the two special surveys are not fully comparable because of differences in coverage and procedures used in compiling the data. The coverage of the two special surveys differs significantly because the estimates were made for all nonrespondents in 1960 and because cranberry growers were included in the 1960 but not in the 1955 special survey. The nonrespondents in 1960 total 4,600 farm operators, with 63,145 acres irrigated as estimated on the basis of figures for the 1959 Census of Agriculture for the same farm operators. Estimates were prepared for these 4,600 farms for 1960, and these estimates comprise a part of the published totals. The farms for which estimates were made for 1960 represented 15.4 percent of the total farms reporting irrigation and the acres irrigated estimated for these farms represents 3.4 percent of the total acres irrigated in 1960. The nonrespondents for 1955 total 7,762 farm operators with 42,307 acres irrigated in 1954. These nonrespondents represent 36 percent of all the farm operators in the 28 States with irrigation in 1954, and had 7 percent of the acres irrigated in 1954. There were 1,134 farms reporting 22,598 acres of cranberries harvested in 1954 in the 28 States. These farms and the acres irrigated were omitted from the 1955 Special Survey. Farms with cranberries represented approximately 5 percent of the farms with irrigation in 1954 and the irrigated acreage of cranberries represented about 4 percent of the total acreage of irrigated land in 1954.

To provide reasonable comparable data for the 1955 and 1960 surveys for the 28 States included in both surveys it would be necessary to increase the number of farms with irrigation for 1955 by approximately 74 percent and the acres irrigated by approximately 10 percent.

The number of farms with irrigation in the 28 States for the two special surveys, 21,700 for 1960 and 11,997 for 1955, are not fully comparable. The total acres irrigated for 1955 were compiled by adding the acres of the individual crops which were irrigated. The irrigated acreages shown, for that survey (1955 in State Tables 2, 3, and 8) are, therefore, overstated to the extent that two or more crops were harvested from the same land.

In the 1955 Survey, some facts, for example, the acreage of the individual crops which were irrigated, were obtained for the 1954 calendar year and for the 1955 calendar year. For other items of information, such as the presence of constructed reservoirs, the type of power used, etc., reference was not made to 1954 or 1955. If irrigation water was used in either year, but not in both years, the report was included in the published totals. The 1955 Survey totals for the 28 States include data for 1,667 farms with irrigated land in 1954, but no land irrigated in 1955. For 1960, the tabulations do not include data for farms with land irrigated in 1959, but with no land irrigated in 1960. There were 9,086 farms with land irrigated in 1959 but with no land irrigated in 1960 in the 30 States. These 9,086 farms had 218,304 acres of irrigated land in 1959.

The extent of irrigation in a given year is influenced by weather conditions, particularly during the growing season. In the summer growing months in the Humid Areas rainfall is variable from year to year and from month to month. Crops and pastures frequently suffer from lack of rainfall. The maps on precipitation appearing on pages VIII to XXV provide rough measures of the needs for irrigation in 1954, 1955, 1959, and 1960. The variations in rainfall have a significant effect upon the area irrigated for all crops except rice and cranberries in an area and a given year. While the acreage irrigated in the Humid Area has been increasing in recent years, the acreage irrigated and the comparison of the acreage irrigated for one or two years are influenced greatly by rainfall during the summer months.

DEFINITIONS AND EXPLANATIONS

Irrigation.--In the enumeration for the 1959 Census of Agriculture, and in the subsequent special 1960 Survey relating to irrigation, farm operators were not given a definition of "irrigation" or of "irrigated land." It is believed that the meaning of the irrigation inquiry on the 1959 Census of Agriculture questionnaires, viz, "Of the total land in this place (reported in question 203), how many acres were irrigated this year?" was understandable to most farm operators. However, in a few instances the farm operator, when canvassed in the 1960 Survey, reported that he had not irrigated any land in 1959. Reports of this nature were not included in the 1960 tabulations and, if received before publication of the final report of the 1959 Census of Agriculture, were removed from the 1959 Census of Agriculture totals for farms reporting and acres of irrigated lands.

Irrigated land is defined as land watered for agricultural purposes by artificial means. These means include subirrigation as well as systems whereby water was applied to the ground surface, either by gravity flow or by sprinklers. Land flooded for rice or cranberry cultivation was considered as irrigated. In the 1959 Census, the greenhouse area was not always considered as irrigated land. If the greenhouse area was reported as irrigated, the report was accepted provided the area was one acre or more. If the greenhouse area was not reported as irrigated or if the area was less than one acre, the greenhouse area was not considered as irrigated. Land flooded during high-water periods was to be included as irrigated only if water was directed to agricultural use by dams, canals, or other works. The definition of irrigated land specifically excluded land where the "water table," or natural level of underground water, was controlled by drainage works with no additional water brought in by canals or pipes.

Census Definition of a Farm.-For the 1959 Census of Agriculture, the definition of a farm was based primarily on a combination of "acres in the place" and the estimated value of agricultural products sold.

The word "place" was defined to include all land on which agricultural operations were conducted at any time in 1959 under the control or supervision of one person or partnership. Control may have been exercised through ownership or management, or through a lease, rental, or cropping arrangement. Places of less than 10 acres in 1959 were counted as farms if the estimated sales of agricultural products for the year amounted to at least \$250. Places of 10 or more acres in 1959 were counted as farms if the estimated sales of agricultural products for the year amounted to at least \$50. Places having less than the \$50 or \$250 minimum estimated sales in 1959 were also counted as farms if they could normally be expected to produce agricultural products in sufficient quantity to meet the requirements of the definition. This additional qualification reresulted in the inclusion as farms of some places engaged in farming operations for the first time in 1959 and places affected by crop failure or other unusual conditions.

For the 1954 Census of Agriculture, places of 3 or more acres were counted as farms if the annual value of agricultural products, whether for home use or for sale but exclusive of homegarden products, amounted to \$150 or more. Places of less than 3 acres were counted as farms only if the annual sales of agricultural products amounted to \$150 or more. A few places with very low agricultural production because of unusual circumstances, such as crop failure, were also counted as farms if they normally could have been expected to meet the minimum value or sales criteria.

Farms Reporting and Acres Irrigated .-- Figures for farms reporting (or operators reporting) represent the number of farms (or operators) for which a specified item was reported. The "number of irrigated farms" and the "number of farms reporting irrigated land" are equivalent terms. Data for "land in farms reporting irrigation" relate to the entire acreage in those farms. including land which was not irrigated. Data for "land irrigated in farms reporting" relate only to that part of the land in irrigated farms that was watered by artificial means in the specified year. The acreage of land irrigated in a particular farm is almost always smaller than the total acreage of the farm. The following data for the State of New York illustrate the meaning of the various terms used above. For example, in 1960, reports of irrigation were received for 1,217 farms which had a combined total area of 186,735 acres. These farms had 50,541 acres of land irrigated in 1960. Only 460 of these irrigated farms reported Irish potatoes as one or the only crop irrigated. The irrigated area of this crop for the State was 26,593 acres. In the tables showing separate data for New York, these totals appear under the following heads:

Farms reporting irrigation number	1,217
Land in farms reporting irrigation acres	186,735
Land irrigated in farms reporting acres	50,541
Irish potatoes irrigated farms reporting	460
acres irrigated	26,593

In the report on crops irrigated, the acreage of each irrigated crop was to be reported even though more than one crop was harvested on the same land in 1960. Therefore, the total acres of crops reported for a State may exceed the total acres of land irrigated.

Space was provided for the reporting on the questionnaire and for punching on to tabulating cards, of tenths of acres for all crops except field corn, hay, and pasture. County and State totals are always shown in whole numbers. An acreage of less than one for any particular crop, for a county, was not retained. No provision was made for the reporting, or punching, of tenths of acres for total acres irrigated. If the number reported for the acreage for total land irrigated included a fraction, the fractional part was cancelled, the whole number being retained or increased by one depending on the value of the fraction. These processing procedures sometimes resulted in discrepancies other than those due to multiple-cropping, between the total of the acres of individual crops irrigated, including pasture, and the total acres of land irrigated. Tenure of Farm or Farm Operator.—Questions 4 through 8 of the 1960 Survey questionnaire provided the basis for the classification by tenure of farm operator for each operation on which irrigation was practiced in 1960. The four tenure groups are defined as follows:

- a. Full Owners operate only land they own.
- b. Part Owners operate land they own and also land rented from others.
- c. Managers operate land for others and are paid a wage or salary for their services. Persons acting merely as caretakers or hired as laborers are not classified as managers. If a farm operator managed land for others and also operated land on his own account, the land operated on his own account was considered as one farm and the land managed for others as a second farm. If, however, he managed land for two or more employers, all the managed land was considered to be one farm.
- d. Tenants rent from others or work on shares for others all the land they operate. In a few cases, where a tenant and his landlord operated separate farms in 1959, only one questionnaire was obtained in 1960 by an enumerator, the questionnaire covering both the tenant and landlord's farming operations.

Year in Which Irrigation was Begun.—The inquiry, "In what year was irrigation begun on this place? (the land reported in question 8)* was intended to ascertain when irrigation was first begun on the farm rather than by the operator who was operating the farm in 1960. Of course, in many cases, the 1960 operator must have been the originator of irrigation on his present farm. For a given area, the information obtained in answer to this question provides a measure of the rapidity of acceptance of this farming practice. In a few areas, such as those in which rice culture has been long established, the exact year of starting irrigation would be difficult for the farmer to report. For that reason, the earlier years have been grouped together. Data for single years are shown only for the more recent years. The groupings were made in a manner to provide some comparisons with data collected for the 1955 Survey.

Some farm operators, who had recently changed farms, no doubt reported the year that they began irrigation on the farm they were operating in 1960. No attempt was made to obtain followup data for this item for questionnaires which did not show the year in which irrigation was begun. For such farms, totals are shown under "Year not reported." State Table 10 provided data by single years back to and including 1955. The years 1950 to 1954 are included in one group, the years 1945 to 1949, in another, and the years 1944 and earlier in another group. The report of the 1955 Survey of Irrigation in Humid Areas presented figures by single years for the year in which irrigation was begun from 1955 back to 1946. The data were grouped for 1945 and earlier years.

Constructed Reservoirs.--No provision was made for securing the size of the constructed storage facilities either in terms of total area or in acre-feet of water impounded. The statistical tables include data for both the number of farms reporting constructed reservoirs and the number of reservoirs. Data for natural lakes and natural ponds are presented under the heading "Source of water." If there was no answer to the inquiry, "How many constructed ponds, pits, dugouts, or constructed reservoirs of any kind for storing irrigation water are there on this place?" and the source of water was given as "Springs and seepage" or "Farm runoff," the number of constructed ponds, etc., was estimated when 10 or more acres of crops other than rice or cranberries were reported. Only occasionally was an estimate of more than 1 made for an individual farm.

Source of Water.—The 1960 questionnaire provided for reporting the percentage of the total water supply used for irrigation obtained from one or more of the following sources:

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- a. Wells
- b. Natural streams and rivers
- c. Springs and seepage (not from streams)
- d. Farm runoff (not from streams)
- e. Natural lakes and natural ponds
- f. Drainage ditches
- g. City, town, or community water supply
- h. Purchases from irrigation or drainage company or district
- i. Other

The percentages on individual questionnaires were totaled to see if they equalled 100 percent. When percentages were not reported, or their total did not equal 100 percent, estimates or adjustments were made. If the correct answer was not ascertainable from other information on the questionnaire, the necessary facts were obtained by correspondence with the farm operator.

For each questionnaire the percentage figures reported were applied to the total acreage irrigated to determine the equivalent acres irrigated from each source of water. If necessary, the resulting acreages were rounded in a manner so that their total would equal the total acreage irrigated. Water sources are in two broad groups, viz, "ground" or "surface." Wells and springs and seepage are considered to be ground sources of water. Natural streams and rivers, farm runoff, natural lakes and natural ponds, and drainage ditches are considered to be surface sources of water. It was not possible to determine the natural source of the water obtained from cities or that which was purchased from irrigation or drainage companies. However, these two water sources are of minor importance in the 30 Eastern States. Irrigation organization sources were reported only in Arkansas and Florida.

State Table 4 shows the number of farms reporting each source of water and the equivalent acres irrigated from each source. In State Table 5, farms reporting a combination of various sources of water are listed in the same order that water sources are listed on the questionnaire. Data for farms whose operators reported several sources are included only once in the totals. For example, farms whose operators reported wells and streams as the source of water are included under the grouping "Wells" and are subtitled "Wells and streams." Data for these farms are not included again under "Natural streams and rivers." The other sources include such sources as canals (for example, the Erie Barge Canal of New York).

Generally, most farms obtained irrigation water from a single source and the significant data in many of the tables may be analyzed by examining the figures for the important sources of water without considering the data for the several groups of farms obtaining water from more than one source.

Method of Application of Water.—The 1960 Survey questionnaire listed five specific methods by which irrigation water could be applied. If in a respondent's opinion his method of applying irrigation water did not fit one of the listed categories, he could report his method by supplying his own description. Thus, if a water tank was used in watering recently transplanted citrus trees (as was the case in a few instances in Florida), that method was an acceptable report for "other." The six categories which permitted an almost automatic classification of the method of applying irrigation water were, as follows:

- a. Portable pipe and sprinklers
- b. Fixed overhead irrigation
- c. Furrows or ditches
- d. Flooding
- e. Subirrigation
- f. Other

When the questionnaire did not have any of these methods reported, an answer based on the method of application used by other farms in the same county was provided during the editing process. However, if the other farms in the county used various methods of application, the answer was determined by a member of the technical staff or through correspondence. Entries of gated-pipe reported under "Other" were transferred to "Furrows or ditches" or "Flooding," depending on the crop irrigated.

More than one method of irrigation may have been utilized on a farm in 1960. Combinations of methods were separated during tabulation. More than one method may have been used to irrigate the same field or tract and in such cases, the total area irrigated by the several methods may exceed the total acres of land irrigated.

A report for acres was required for each method of irrigation. During the editing process fractional acreage was converted to the nearest whole number and the total of the acres listed for the various methods was checked and made to equal the total acreage irrigated, except in those cases where more than one method was utilized to irrigate the same acreage. State Table 3 presents the total acres irrigated by each method in each State. State Table 6 gives the acreage irrigated by the various methods or combinations of methods used in applying irrigation water.

Type of Power Used for Pumping.—The questionnaire for 1960 listed four types of power used for pumping water. A check box for "None" was provided for reporting if no power was used. No power may be required when water flows to the land by artesian action or by some other form of gravity, or under pressure as in the case of city water. Farms for which the type of power was not indicated by the respondent are included in the tables under "Farms not reporting type of power."

A number of farmers reported the use of more than one type of power. The tabulating procedures provided for the obtaining of data for the following power combinations: Gas engines and diesel engines, gas engines and electric motors, gas engines and tractors, diesel engines and electric motors, and diesel engines and tractors. The tabulation program did not provide for combination of other sources of power nor for combination of tractor and electric sources of power. There were 243 farms with such combinations of power sources. These were distributed by State as follows:

The 243 farms with power obtained from these combined sources were included with the source "gas engine."

Crops Irrigated in 1960.—The 1960 Survey questionnaire provided for the farm operator to report the acreage of each crop irrigated and the number of times the crop was irrigated. Ten crops, including pasture, were listed separately. Additional space was provided for the identifying of any other irrigated crop together with the acreage irrigated. The reporting of fractional acreage was provided for all crops except corn, hay, and pasture.

Information on the number of times that crops were irrigated in 1960 is published, where such information is available and meaningful. Because of the nature of cranberry and rice culture, the number of times these crops were irrigated is not given in the tables. The number of times irrigated is not shown for crops which were subirrigated as, in many cases, this is a continuous process. Some growers were not able to report the number of times irrigated for vegetable crops. No effort was made to obtain this information for short-season vegetables when it was not reported.

If the number of times irrigated was not given for 50 or more acres of a crop, other than rice, cranberries, and vegetables, letters were sent to farm operators asking for this information. For acreage ranging from 5 through 49, for which the number of times irrigated was not reported, the number of applications of water was supplied during the editing process on the basis of reports on other questionnaires for the same area. When not reported, the number of times irrigated was not supplied during the editing process when the acreage irrigated was under 5.

When part of a crop was irrigated one number of times and part, another number of times, and when the total acres irrigated for a crop was 20 acres or more, the acres irrigated for each part and the farms reporting were counted separately under the appropriate grouping by number of times irrigated in Table 12.

During the editing process, the area reported for the various crops irrigated on each farm was totaled and this total was checked against the total acres of land irrigated. If the summation gave a total in excess of the acres of land irrigated on a given farm, the difference was checked to see if double-cropping was the cause of the difference. If the difference was not the result of double-cropping, changes were made after correspondence, or on a judgment basis if the difference was small.

Supplementary Uses of Irrigation.—Irrigation water is for purposes other than to sustain and increase vegetative plant growth. Farm operators were asked in 1960 to answer the following inquiry:

- 16. Have you used irrigation for any of the following:
 - a. Preventing frost damage?
 - b. Applying fertilizer materials?
 - c. Easier land preparation?
 - d. Other? (describe)

As noted, the inquiry made no mention of the year in which a practice was initiated or carried out. Some of the replies may have related to an activity for a year prior to 1960. Among the other uses of irrigation water reported were:

- 1. Replacing watering equipment on transplanters
- 2. Applying insecticides
- 3. Applying fungicides
- 4. Watering livestock in fields
- 5. Harvesting cranberries

- 6. Land leveling
- 7. Making compost

SUMMARY OF STATISTICS

Statistics for the United States,--The relative importance of irrigation of agricultural lands in the Humid Areas to the total for conterminous United States is shown by the following data from the 1959 Census of Agriculture:

Amaa	Irrigate 19	ed farms 59	Acres irrigated in 1959	
Area	Number	Percent of total	Acres	Percent of total
Conterminous United States ¹	306,532	100.0	33,021,799	100.0
Humid areas-30 State total ²	39,101	12.8	1,798,832	5.4
Irrigated States-18 State total ²	267,431	87.2	31,222,967	94.6

¹Alaska and Hawaii excluded. ²See text for the included States.

According to this latest census, 39,101 farm operators in the 30 Humid-States Area irrigated 1,798,832 acres of farmland in 1959. They comprised 12.8 percent of the conterminous United States total number of farms with irrigation and their irrigated acreage, 5.4 percent of the United States irrigated farm acreage. More farmers, than those who actually irrigated land in 1959, are equipped to irrigate at least a part of their land-holdings. Because of weather conditions, economic conditions, or other conditions, a farmer equipped for supplying supplemental water to his land may not do so every year. Those who do supplement the available soil moisture, may have sufficient water supplies and equipment to irrigate additional acres.

Farmers in the Humid Areas, as in the Irrigation States, are continuing to equip their farms for irrigation at an accelerating rate. The increase in the irrigated acreage in the Humid Areas did not keep pace with the increase in the number of irrigated farms between 1954 and 1959.

Area and year	Irrigated farms (number)	Area irrigated (acres)
Conterminous United States ¹ 1959	306,532 320,236	33,021,799 29,552,155
1950. 1949. 1945. 1944.	305,061 NA 288,195 NA	NA 25,787,455 NA 20,539,470
Rumid Areas-30 States, total 1959 1954 1950 1949 1945 1944	39,101 33,443 16,147 NA 10,381 NA	1,798,832 1,873,648 NA 940,114 NA 572,484
Irrigation States—18 States, total 1959. 1954. 1950. 1949. 1945. 1944.	267,431 286,793 288,914 NA 277,814 NA	31,222,967 27,678,507 NA 24,847,341 NA 19,966,986

NA Not available. ¹Alaska and Hawaii excluded.

Statistics for Humid Areas.—Of the 39,103 farm operators with irrigation in the 1959 Census of Agriculture, 29,777 met the criteria for inclusion in the 1960 Survey of Irrigation in Humid Areas. The principal test for inclusion was that the 1959 farm operator must either have been a 1960 farm operator or must have been supplanted on the same land by a 1960 farm operator. The 29,777 total comprised 4,600 who did not respond to the mailed inquiry and were not canvassed in the field followup.

The 29,777 farms with irrigation in 1960, had 1,865,178 acres irrigated in that year. This total irrigated area in 1960 was slightly in excess of that reported for the immediately previous year, as recorded in the 1959 Census of Agriculture. North Carolina had more than one-fifth of the 30-State total number of farmers with irrigation in 1960 but, as an average, each farm operator in North Carolina irrigated fewer acres than those in other States. The most frequently irrigated crop in North Carolina was tobacco. Arkansas, Florida, and Mississippi had the largest total area irrigated in 1960. Rice was the leading irrigated crop in Arkansas and Mississippi and citrus fruits and vegetables, in Florida. These three States also had the highest average of irrigated land per farm among the 30 States included in the survey.

The total land area of the irrigated farms, included in the 1960 Survey, was 11,083,788 acres and of this total 16.8 percent, or 1,865,178 acres, was irrigated in 1960. Wells were the source of the water for more than three-fifths (61.7 percent) of the irrigated acreage, and natural streams and rivers were the water sources for about one-seventh (14.3 percent) of the area irrigated. The water for smaller, but significant, acreages, varying by States, was furnished by natural lakes and ponds, subirrigation, drainage ditches, farm runoff, and springs and seepage. Constructed reservoirs were reported on 15,252 of the 29,277 irrigated farms. The number of constructed reservoirs totaled 32,948.

On most of the irrigated farms, some source of power, other than gravity, was utilized by the operator in getting water to his crops. Gas engines were reported as the source of power by 15,480 farm operators, electric motors by 4,822, and tractors by 4,360. Definite reports of "No power" were made by 985 operators and 5,044 failed to report the type of power used for pumping.

Irrigation water can be used for purposes other than to add to the available soil water for crop production. When light frost or slightly below freezing weather conditions occur severe damage can be averted by applying water to the ground surface or as a spray over the vegetative growth. This supplemental use of irrigation water was given more often than any other, being reported by 3,684 farm operators. About 3,000 (2,986) farm operators reported the use of irrigation water to distribute fertilizer and 2,231 the use of water as an aid in land preparation.

Of the 158 farms with 1,000 or more acres irrigated in 1960, 141 were located in Arkansas or Florida. Nearly one-fourth of the total number of 29,777 irrigators were tenant farm operators. The "Year in which irrigation was begun on the place" was not reported for 7,158 farms. For 4,600 of this latter group (those who failed to mail back a report) no effort was made to estimate the beginning date. Definite reports indicated that for 8,351 farms irrigation was first begun on the farm after the calendar year 1955.

For the 30-State group, the largest single irrigated crop acreage in 1960 was rice with 424,657 acres. This was followed by soybeans with 281,300 acres, and cotton with 245,924 acres. Irrigated vegetable acreage, totaled 271,641 acres with snap beans, tomatoes, and sweet com together contributing about 40 percent of the irrigated vegetable acreage. Fruits and nuts, inclusive of cranberries and other berry fruits were harvested on 161,899 acres of irrigated land. Irish potatoes, not grouped with vegetables, were produced on 94,739 irrigated acres, tobacco on 89,211 acres, and nursery and greenhouse crops on 41,660 acres. For purposes of the 1960 Survey, pasture was a listed crop and 164,537 acres of such land were reported as irrigated. State Table 12 and County Table 1 indicate the geographic distribution of the irrigated crops.



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IRRIGATION IN HUMID AREAS







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