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Introduction

PURPOSE AND SCOPE OF THE SURVEY

The 1994 Farm and Ranch Irrigation Survey was conducted to supplement the basic irrigation data collected from all farm and ranch operators in the 1992 Census of Agriculture. The survey provides detailed information relating to on-farm irrigation practices without burdening all farm and ranch operators. The information includes statistics on acres irrigated by category of land use, acres and yields of irrigated and nonirrigated crops, quantity of water applied and method of application to selected crops, acres irrigated and quantity of water used by source, acres irrigated by type of water distribution systems, and number of irrigation wells and pumps. Also included are irrigation expenditures in 1994 for maintenance and repair of irrigation equipment and facilities; purchase of energy for on-farm pumping of irrigation water; investment in irrigation equipment, facilities, and landimprovement; and costs of water received from off-farm water suppliers.

Irrigation data from this survey and from the 1992 Census of Agriculture provide a relatively complete and detailed picture of irrigation in the conterminous United States.

The irrigation operations sampled for this survey were selected from irrigated farms and ranches identified in the 1992 Census of Agriculture, excluding all irrigators in Alaska and Hawaii, and all abnormal and horticultural specialty farms in the 48 conterminous States. Therefore, 32,930 irrigation operations were excluded from sample selection. Most of the excluded irrigated farms were horticultural specialty farms and accounted for 1,304,967 acres irrigated, or 2.6 percent of the land irrigated in 1992.

In addition, results of the survey show that 17,261 irrigation operations in 1992 with 3.3 million acres irrigated discontinued farming since 1992. No attempt was made to identify and select new irrigation operations for 1994.

Selected irrigation data for on-farm irrigation operations have been collected in the census of agriculture since 1890. A census of farms reporting irrigation in the 1900 Census of Agriculture was authorized by Congress. Surveys of irrigation in humid areas were taken in connection with the 1954 and 1959 censuses. The 1994 Farm and Ranch Irrigation Survey is the fourth survey devoted entirely to the collection of on-farm irrigation operations for the conterminous United States. The 1979,

1984, 1988, and 1994 Farm and Ranch Irrigation Surveys collected similar data using similar methods and procedures of data collection and processing.

AUTHORITY AND AREA COVERED

The census of agriculture is authorized under the provisions of Title 13, United States Code. Section 182 authorizes the Secretary of Commerce to conduct surveys deemed necessary to furnish annual or other data on the subjects covered by the census. The 1994 Farm and Ranch Irrigation Survey was conducted under the provisions of this section.

FARM DEFINITION

Since 1850, when minimum criteria defining a farm for census purposes were first established, the farm definition has been changed nine times. The current definition, used since 1974, is any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year.

WATER RESOURCES AREAS MAP

The map shows water resources areas delineated on the basis of county boundaries that approximate actual basin boundaries based on topographic drainage characteristics. Data are tabulated separately for each of the 18 water resources areas shown on the map.

PERCENT OF NORMAL PRECIPITATION MAP

The map shows the areas of the conterminous United States where other than a normal amount of rain fell during 1994. This map is included for reference purposes only.

TABULAR PRESENTATION

Table 1 shows farms and acres irrigated for the censuses of 1969 through 1992 for each State summarized by census divisions and regions. Tables 2 through 34 present detailed irrigation operation information collected from irrigation operations which reported irrigated land in

the 1992 Census of Agriculture, and who also irrigated in 1994.

Table 35 presents data for farm operations who irrigated in 1992, but discontinued irrigation either temporarily or permanently in 1994 while continuing to operate a farm or ranch.

Tables 2 through 35 present data from the 1994 Farm and Ranch Irrigation Survey separately for each of the 27 leading irrigating States, all other States combined, and for each of the 18 water resources areas.

Additional text tables are shown in the General Explanation.

ELECTRONIC DATA DISSEMINATION

The 1994 Farm and Ranch Irrigation Survey data are available electronically on CD-ROM. Separate CD-ROM files are available for the 1987 and 1992 Censuses of Agriculture and the 1988 Farm and Ranch Irrigation Survey. To purchase CD-ROM files, contact Agriculture and Financial Statistics Division, Census Bureau (telephone 800-523-3215).

SPECIAL TABULATIONS

Custom designed tabulations can be developed to individual user specifications on a programming cost reimbursable basis. Inquiries about special tabulations should be directed to the Chief, Agriculture and Financial Statistics Division, Bureau of the Census, Washington, DC 20233.

CENSUS DISCLOSURE RULES

In keeping with the provisions of Title 13, United States Code, no data are published that would disclose the operation of an individual farm. However, the number of farms and ranches in a given size category or other classification is not considered a release of confidential information and is provided even though other information is withheld.

DEFINITIONS AND EXPLANATIONS

Definitions and explanations of selected terms used in the tables are further defined in the General Explanation.

ABBREVIATIONS AND SYMBOLS

The following abbreviations and symbols are used throughout the tables:

-	Represents zero.
cwt	Hundredweight.
(D)	Withheld to avoid disclosing data for individual farms.
(GPM)	Gallons per minute.
(NA)	Not available.
(psi)	Pounds per square inch.
(Z)	Less than half of the unit shown.
WRA	Water Resources Areas.
(X)	Not applicable.

General Explanation

PLANNING AND DEVELOPMENT

Planning for the survey started in 1992 with a review of the previous farm and ranch irrigation surveys. Letters were sent to individuals in water-related government organizations, industry, and academic positions to solicit their comments on report form content and format. Presentations were made to several associations seeking their comments. All responses were reviewed and categorized to evaluate data collection feasibility and priority needs.

The same basic methods and procedures used in conducting the 1988 Farm and Ranch Irrigation Survey were followed with the 1994 survey in order to maintain comparability and efficiency of data collection and processing. The 1994 sample size remained relatively the same as the 1988 survey, increasing only slightly from 19,324 to 19,998 irrigators. Additional data inquiries were added to the 1994 report form to collect more detailed information about items such as gravity irrigation and irrigation management practices.

METHOD OF ENUMERATION AND DATA COLLECTION

The 1994 Farm and Ranch Irrigation Survey was conducted by mail and supplemented by telephone calls to selected nonrespondents. The report forms were mailed to a sample of 19,998 irrigation operations in January 1995. The initial mail package included a report form imprinted with a letter requesting a prompt response. The operator of the irrigation operation was asked to complete and mail the report form to the Bureau of the Census. The initial mailing was followed by a thank you post card and three mail follow-ups between the second week of February and the third week of April. All follow-ups consisted of a reminder letter and a report form. Telephone calls were made at the conclusion of the enumeration period to all nonrespondents who reported large irrigation operations in the 1992 Census of Agriculture. Data collection was completed in June 1995 with a 74 percent overall response. For a description of the adjustment for nonresponse, see Statistical Methodology.

DATA PROCESSING

All report forms were reviewed prior to data keying to identify major inconsistencies and to ensure that the data could be keyed. Respondent remarks and major inconsistencies were corrected and all large irrigation cases were reviewed by statisticians before data keying. Computer checks were made for inconsistent data items. Computer edits imputed missing data based on farms within the same geographic area. Analysts reviewed and corrected inconsistencies identified in the computer checks.

Prior to publication, tabulated totals were reviewed to identify remaining inconsistencies and potential coverage problems. Comparisons were made to 1992 census data and other check data.

COMPARABILITY OF DATA

Data users need to be aware that differences exist between the expanded results of the 1994 Farm and Ranch Irrigation Survey and published data from the 1992 Census of Agriculture. Some of these are:

1. The survey does not include irrigation operations in Alaska, Hawaii, and horticultural specialty and abnormal farms in the 48 conterminous States. The effect of the excluded farms is:

	Irrigated farms	Acres irrigated
1992 U.S. totals.....	279,357	49,404,030
Excluded from survey...	32,930	1,962,217
Eligible for selection in survey	246,427	47,441,813

2. The survey includes data only for irrigation operations who irrigated in both 1992 and 1994. Operators in some areas, especially the Eastern

States, irrigate intermittently according to moisture needs. Operations having irrigation capabilities may not irrigate depending on the amount of rainfall for a particular year or geographic area. The number of operations which irrigated in 1992 but discontinued irrigation in 1994 are included in table 35 by reason of discontinuance.

3. Some operations reported that they had been misclassified as irrigators and did not irrigate in either 1992 or 1994. An estimated 6,797 operations with 366,809 acres irrigated in 1992 were classified as irrigation operations in the 1992 census but reported that they did not irrigate in 1994 nor in 1992. In addition to errors in processing data, some operations misreported or misinterpreted the questions. Most of the operations misreporting irrigation in the census reported irrigation of small acreages of vegetables, fruits and nuts, tobacco, potatoes, or berries. Small amounts of water were applied to these crops at the time of transplanting.

4. Some respondents indicated that they had quit farming, retired, moved, gone bankrupt, etc., since 1992. After analytical review of the 1994 receipts, an estimated 17,261 operations accounting for 3,258,534 acres irrigated in 1992 were dropped from processing because they were no longer farming. Special care was taken with large cases to ensure that they were not erroneously dropped due to reorganization or name change rather than discontinuing agricultural operations.

5. New irrigation operations in 1994 (not included in the 1992 census) did not have a chance of being selected in the sample and, therefore, were excluded from the survey. It is believed that the impact of new irrigation operations is probably minimal.

When comparing the number of farms and irrigated acres between the 1994 survey and the 1992 census published U.S. totals, most of the differences are for operations reporting less than 100 acres irrigated. This is expected since the excluded horticultural farms average about 20 acres irrigated per farm and the other categories of discontinued or excluded irrigation operations generally are smaller than average operations. Table A shows acres irrigated in the 1994 survey (expanded) compared with U.S. totals from the 1992 census. The expanded survey accounts for 94 percent of all land reported as irrigated in the 1992 census and all irrigation characteristics associated with that land.

Table A. Comparison of Irrigated Farms and Acres by Acres Irrigated: 1994 Survey With 1992 Census

Item	1994 survey (expanded)		1992 published U.S. totals
	Total	Percent of 1992 census totals	
Land irrigated.....farms ..	198,115	70.9	279,357
 acres...	46,418,380	94.0	49,404,030
1 to 9 acres.....farms....	39,447	46.4	84,998
acres....	147,759	51.4	287,503
10 to 49 acres.....farms....	49,756	72.3	68,568
acres....	1,178,285	72.5	1,624,314
50 to 99 acres.....farms....	23,497	79.1	29,716
acres....	1,638,930	79.1	2,071,829
100 to 199 acres.....farms....	24,907	77.5	32,126
acres....	3,414,004	76.7	4,452,976
200 to 499 acres.....farms....	33,939	90.4	37,529
acres....	10,603,943	90.0	11,783,089
500 to 999 acres.....farms....	17,421	98.8	17,641
acres....	12,000,582	99.9	12,010,686
1,000 acres or more.....farms ...	9,148	104.2	8,779
acres....	17,433,817	101.5	17,173,633

DEFINITIONS AND EXPLANATIONS

This section provides definitions and explanations of selected items that are used on the report form or in the tables. A facsimile of the 1994 Farm and Ranch Irrigation Survey report form is in the appendix.

Water Resources Areas (WRA)

Data from the 1994 Farm and Ranch Irrigation Survey were tabulated by WRA. Boundaries of these areas are shown in the map on page XX. These areas are essentially the same as the water resources regions (WRR) as delineated and defined in the past by the U.S. Water Resources Council. The areas differ somewhat from the regions because of the method used for boundary delineation. Region boundaries are delineated on the basis of topographic drainage characteristics; whereas, areas are delineated on the basis of county boundaries which approximate actual drainage-basin boundaries.

Geographic descriptions of each water resources region that can be used to approximate the area included in each water resources area are:

01 New England Region—The drainage within the United States that ultimately discharges into the Bay of Fundy and the Atlantic Ocean. These points of discharge are located within and between Maine and Connecticut;

Long Island Sound and the St. Francis River, a tributary of the St. Lawrence River.

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

03 South Atlantic-Gulf Region—The drainage that ultimately discharges into the Atlantic Ocean, whose point of discharge is located within and between North Carolina and Florida; and the Gulf of Mexico, whose point of discharge is located within and between Florida and Mississippi, including the Pearl River.

04 Great Lakes Region—The drainage within the United States that discharges into the Great Lakes system, including the Lakes' surfaces; and the St. Lawrence River as far east as, but excluding the Richelieu River.

05 Ohio Region—The drainage of the Ohio River, excluding that of the Tennessee River.

06 Tennessee Region—The drainage of the Tennessee River.

07 Upper Mississippi Region—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 River—The drainage of the Mississippi River below the mouth of the Ohio River, but excluding the drainage of the Arkansas, White, and Red Rivers and above the points of highest backwater affects of the Mississippi River in those parts; and the coastal streams, other than the Mississippi River, that discharge into the Gulf of Mexico from the boundaries of, but excluding the Pearl and Sabine Rivers.

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

10 Missouri Region—The drainage within the United States of the Missouri River above a point immediately below the mouth of the Gasconade River and the Saskatchewan River.

11 Arkansas-White-Red Region—The drainage of the Arkansas River above the point of highest backwater affect of the Mississippi River, the Red River above the point of highest backwater affect of the Mississippi River, and the White River above the point of highest backwater affect of the Mississippi River near Peach Orchard Bluff, AR.

12 Texas-Gulf Region—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 Region—The drainage within the United States of the Rio Grande; the San Luis Valley, North Plains, San Augustine Plains, Mimbres, Estancia Jonado del Muerto, Tularosa, Salt, and various smaller closed basins; and the Lower Rio Grande Valley.

14 Upper Colorado Region—The drainage of the Colorado River above the Lee Ferry Compact Point, which is about 1 mile below the mouth of the Paria River; and the Great Divide closed basin.

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

16 Great Basin Region—The drainage of the Great Basin that ultimately discharges into Utah and Nevada.

17 Pacific-Northwest Region—The drainage within the United States that ultimately discharges into the Straits of Georgia and Juan de Fuca and the Pacific Ocean. The point of discharge is within Washington and Oregon, including the Columbia River.

18 California Region—The drainage within the United States that ultimately discharges into the Pacific Ocean, whose point of discharge is within California, which includes the Central Valley; and that portion of the Great Basin and other closed basins in California.

Irrigated Farms

Irrigated farms or ranches are those with any agricultural land irrigated in the specific calendar year. The acreage irrigated may vary from a very small portion of the total acreage in the farm or ranch to irrigation of all agricultural land in the farm or ranch.

Acres Irrigated

Acres irrigated are the acres of agricultural land to which water was artificially applied by controlled means including preplant, partial, supplemental, and semi-irrigation. Land flooded during high water periods was to be included as irrigation only if the water was diverted to agricultural land by dams, canals, or other works.

Sprinkler Irrigation

Sprinkler irrigation is divided into four areas to reflect current trends in irrigation. The center pivot method has high pressure delivery which has water at 60 psi or greater, medium pressure delivery which has water at 30 to 59 psi, and low pressure delivery which is any system that uses water at less than 30 psi. The mechanical-move systems are classified as either linear and wheel move systems where the water is delivered below the leaf canopy or as all other.

On-Farm Surface Supply

On-farm surface supply is water from a surface source not controlled by a water supply organization. It includes sources such as streams, drainage ditches, lakes, ponds, and reservoirs on or adjacent to the operated land.

Off-Farm Water Supply

Off-farm water supply is water from off-farm water suppliers, such as the U.S. Bureau of Reclamation; irrigation districts; mutual, private, cooperative, or neighborhood ditches; commercial companies; or community water systems.

Acre-Foot of Water

An acre-foot of water is the quantity of water required to cover 1 acre to a depth of 1 foot. This is equivalent to 43,560 cubic feet or 325,850 gallons.

Flowing or Artesian Wells

Flowing or artesian wells are wells which flow freely and provide water used for irrigation without pumping. There were no provisions made on the report form to report flowing or artesian wells. Therefore, all of these wells had to be identified during the processing of the survey from remarks or other indications made by the respondent. Where respondents indicated a well was flowing or artesian and did not require pumping, it was classified to be free flowing.

All flowing or artesian wells were excluded from pumping data in tables 13 and 15. This should be taken into consideration when using data from these two tables.

Land in Farms

Acreage designated in the tables as "land in farms" consists primarily of agricultural land used for crops, pasture, or grazing. Also, it includes woodland and wasteland not actually under cultivation or used for pasture or grazing, provided it was part of the farm operator's total operations. Large acreages of woodland and wasteland held for nonagricultural purposes were

deleted from individual reports during the processing operations.

Land in farms is an operating unit concept that includes land owned and operated as well as land rented from others. Land used rent free was to be reported as land rented from others. All grazing land, except land used under government permits on a per-head basis, was included as "land in farms" provided it was part of a farm or ranch.

Total Cropland

Total cropland includes all harvested cropland, cropland used only for pasture or grazing, and other cropland.

Cropland Harvested

Cropland harvested is land from which crops were harvested or hay was cut; and land in orchards, citrus groves, vineyards, nurseries, and greenhouses. Land from which two or more crops were harvested was counted only once, even though there was more than one use of the land.

Cropland Used Only for Pasture or Grazing

Cropland used only for pasture or grazing is land used only for pasture or grazing that could have been used for crops without additional improvement. Also included was all cropland used for rotation pasture and land in government diversion programs that was pastured. However, cropland that was pastured before or after crops were harvested was to be included as harvested cropland rather than cropland for pasture or grazing.

Other Cropland

Other cropland includes cropland not harvested and not grazed which was used for cover crops, soil-improvement crops, land on which all crops failed, cultivated summer fallow, idle cropland, and land planted in crops that were to be harvested after the survey year.

Woodland

Woodland includes natural or planted woodlots or timber tracts, cutover and deforested land with young growth which has or will have value for wood products, land planted for Christmas tree production, and woodland pastured. Land covered by sagebrush or mesquite was to be reported as other pastureland and rangeland or other land.

Other Land

Other land includes land in house lots, barn lots, ponds, roads, and wasteland.

Market Value of Agricultural Products Sold

The market value of agricultural products sold represents the gross market value before taxes and production expenses of all agricultural products sold or removed from the place in 1992 regardless of who received the payment. It includes sales by the operator as well as the value of any shares received by partners, landlords, contractors, and others associated with the operation. The market value of agriculture products sold represents the sum of all crops including nursery products, and livestock and poultry and their products. It does not include income from farm-related sources, such as customwork or agricultural services, or income from nonfarm sources. These data were taken from the 1992 Census of Agriculture report form for the sample survey respondents.

The market value of agricultural products sold in 1992 does not necessarily represent the sales from crops harvested in 1992. Data includes sales from crops produced in earlier years and excludes some crops produced in 1992, but held in storage and not sold in 1992. For crops sold through a co-op which made payments in several installments, only the total payments received in 1992 were to be reported.

Acres and Quantity Harvested

If two or more crops were harvested from the same land during the year, the acres would be counted for each crop. Therefore, the total acres of all crops harvested generally exceed the acres of harvested cropland. The exception to this procedure is hay crops. When more than one cutting of hay was taken from the same acres, the acres were counted only once, but the quantity harvested included hay from all cuttings. For interplanted crops or "skip-row" crops, acres were to be reported according to the portion of the field occupied by each crop.

If a crop was planted but not harvested, the acreage was not to be reported as harvested. These acres were to be reported in the "land use" section under the appropriate cropland items -- cropland used only for pasture or grazing or other cropland.

Acres of land in bearing and nonbearing orchards--citrus or other groves, vineyards, and nut trees--were to be reported as harvested cropland regardless of whether the crop was harvested or failed. However, abandoned orchards were to be reported as cropland idle, not as harvested cropland or for the individual crop acreage.

Crop Unit of Measurement

Respondents were instructed to report each crop in the same unit of measure in all areas. For example, corn for grain or seed was reported in bushels shelled, and rice was reported in hundredweight.

Farms by Standard Industrial Classification

Irrigated farms and ranches are classified by standard industrial classification (SIC), as described in the 1987 SIC Manual. This classification was designed to promote uniformity and comparability for statistical data collected by various agencies. An establishment (farm, ranch, nursery, greenhouse, etc.) primarily engaged in crop production (major group 01) or livestock production (major group 02) is classified in the three- or four-digit industry group which accounts for 50 percent or more of the total value of sales from agricultural products. If the total value of agricultural products sold by an establishment was less than 50 percent from a single four-digit industry, but 50 percent or more from the products of two or more four-digit industries within the same three-digit industry group, the establishment was classified in the miscellaneous industry of that industry group; otherwise, it was classified as a general crop farm in industry 0191 or a general livestock farm in industry 0291.

All farms in the 1992 census were classified by SIC. Classifications of irrigated farms by selected SIC groupings are shown in table 27. The SIC codes for survey respondents were obtained from their 1992 Census of Agriculture report form.

Leading Irrigation States

Data for 1988 are shown at the summary level for purposes of comparability with the 1994 Farm and Ranch Irrigation Survey. This includes data for the 17 Western States which are: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

Table B shows the top 20 irrigation States according to the 1992 Census of Agriculture.

Abnormal Farms

Abnormal farms were not included in the survey universe. These are institutional farms, experimental and research farms, and Indian reservation farms. Institutional farms include those operated by hospitals, penitentiaries, churches, schools, grazing associations, etc. In 1992, 590 abnormal farms accounted for 373,493 acres irrigated or less than 0.8 percent of all acres irrigated in the United States.

STATISTICAL METHODOLOGY

Universe

The universe for the survey included all irrigated farms identified in the 1992 Census of Agriculture, except farms in Alaska and Hawaii, horticultural specialty farms, and abnormal farms. The farms in the three excluded categories represent 11.8 percent of the total number of

Table B. Leading Irrigation States: Census Years 1992, 1987, and 1982

Geographic area	Acres irrigated			Rank			1992 cumulative percent of U.S. total
	1992	1987	1982	1992	1987	1982	
United States	49,404,030	46,386,201	49,002,433	(X)	(X)	(X)	100.0
20 leading States.....	45,703,882	42,936,801	45,963,550	(X)	(X)	(X)	92.5
California	7,571,313	7,546,091	8,460,508	1	1	1	15.3
Nebraska	6,311,633	5,681,835	6,039,292	2	2	2	28.1
Texas.....	4,912,308	4,271,043	5,575,553	3	3	3	38.0
Idaho	3,260,006	3,219,192	3,450,443	4	4	4	44.6
Colorado	3,169,839	3,013,773	3,200,942	5	5	5	51.1
Kansas	2,680,343	2,463,073	2,675,167	7	6	8	62.0
Arkansas	2,701,651	2,406,338	2,022,695	6	7	6	56.5
Montana.....	1,978,167	1,996,882	2,023,003	8	8	7	66.0
Oregon	1,622,235	1,648,205	1,807,882	11	9	9	76.2
Florida	1,782,680	1,622,750	1,585,080	9	10	11	70.0
Washington.....	1,641,437	1,518,684	1,638,470	10	11	10	72.9
Wyoming.....	1,464,585	1,517,891	1,564,576	12	12	12	79.1
Utah.....	1,142,514	1,161,207	1,082,328	13	13	14	81.4
Arizona	956,454	913,841	1,097,825	14	14	13	83.4
Nevada	556,172	778,977	829,761	20	15	15	92.5
New Mexico.....	738,272	718,449	807,206	17	16	16	88.5
Louisiana	897,641	646,677	693,698	15	17	17	85.2
Georgia.....	724,792	640,256	575,306	18	18	18	89.9
Mississippi.....	882,976	636,842	430,901	16	19	20	87.0
Missouri.....	708,864	534,795	402,914	19	20	21	91.4

irrigation operations and 5.9 percent of the irrigated land reported in the 1992 Census. Reference year for the survey is 1994. The Farm and Ranch Irrigation Survey universe excluded farms that began operating in 1994 or had succeeding irrigators in 1994 (an operator who, since 1992, took over control of an irrigating farm through sales, rental, or other arrangements). The universe does not include farms not irrigating in the 1992 census but possibly irrigating in 1994. The universe included some operations erroneously identified as irrigating in the 1992 census either due to reporting or census processing errors. Table C provides counts of the initial mailout, the final processed and tabulated reports, and the 1992 farms eligible for the survey.

Sample Design

The global Farm and Ranch Irrigation Survey sample allocation of 20,000 was originally designed to provide a relative standard error not exceeding 10 percent on estimated irrigated acreage at State level for the 27 leading irrigation States, as well as at the collective level for the combined 21 other States, hence yielding a national-level relative standard error no larger than 10 percent on this variable. The estimates for this survey are based on a probability sample of farms that irrigated in 1992 and were identified in the 1992 Census of Agriculture. The total sample of 19,998 irrigators represented approximately 8.1 percent of the 246,427

irrigated farms in the survey universe and accounted for 33.1 percent of the 47.4 million acres of irrigated land.

The sample included all farms identified as irrigating 2,000 acres or more in Missouri, Montana, Nebraska, Oklahoma, Oregon, and Washington; 2,500 acres or more in Arkansas, Colorado, Georgia, Idaho, Michigan, Texas, and Wyoming; 3,000 acres or more in Florida, Kansas, and Mississippi; 3,500 acres or more in Arizona; 5,000 acres or more in California and Nevada; and 1,500 acres or more in the remaining States. The total number of these design certainty farm operations, sampled at the rate of one-in-one, came to 1,175.

All farm operations eligible for the survey were stratified on the basis of stratum group, and, within stratum group, by 1992 census-reported total irrigated acres. Thirty-four stratum groups were defined for the conterminous United States. These survey design units were constituted by the 27 leading irrigating States covering the Midwest and Western regions, and the seven Water Resources Areas (WRAs) defining the Eastern region. The stratum assignment, based on the 1992 reported irrigated acreage, varied from stratum group to stratum group. For each stratum of a stratum group, an independent systematic sample of farms was selected. The sample size assigned to each of the noncertainty strata was defined as the maximum of a Neyman allocation and an allocation proportional to the stratum's share of the stratum group's 1992 total irrigated acreage. From these noncertainty strata, a sample of 18,823 farms

Table C. Irrigated Farms: 1994 Survey and 1992 Census

Geographic area	1994 survey						1992 census			
	Initial mailout counts		Final reports processed and tabulated				Published totals		Sample universe ¹	
			Unexpanded		Expanded					
	Farms (number)	1992 acres irrigated (1,000)	Farms ² (number)	Acres irrigated (1,000)	Farms ³ (number)	Acres irrigated (1,000)	Farms (number)	Acres irrigated (1,000)	Farms (number)	Acres irrigated (1,000)
Conterminous United States	19 998	15 497	12 735	10 593	216 902	46 418	277 044	49 268	246 427	47 442
27 leading irrigating States	17 653	14 973	11 266	10 256	204 918	45 591	248 715	48 171	229 179	46 493
All other States	2 345	525	1 469	337	11 984	827	28 329	1 097	17 248	949
Arizona	591	572	330	340	3 165	752	3 965	956	3 671	840
Arkansas	704	710	446	493	6 227	2 854	6 682	2 702	6 444	2 676
California	1 323	2 086	828	1 594	50 126	7 245	56 546	7 571	53 022	7 224
Colorado	663	612	480	462	12 934	2 999	15 193	3 170	14 752	3 094
Florida	668	1 098	459	910	7 815	1 416	13 500	1 783	9 114	1 542
Georgia.....	508	314	241	140	3 534	620	4 701	725	3 960	695
Idaho	707	787	454	555	14 037	3 184	15 487	3 260	14 988	3 110
Illinois	711	259	497	184	1 149	272	2 061	328	1 523	307
Kansas	604	721	394	474	5 447	2 502	6 543	2 680	6 344	2 675
Louisiana	561	327	288	196	3 125	821	4 064	898	3 656	891
Michigan.....	697	243	499	165	2 629	305	3 823	366	2 649	340
Minnesota.....	674	256	419	184	1 594	327	2 368	370	1 949	363
Mississippi.....	816	758	480	421	1 406	647	2 127	883	1 876	873
Missouri.....	726	504	448	323	1 992	702	2 914	709	2 542	702
Montana.....	571	575	390	389	8 291	1 936	8 883	1 978	8 717	1 948
Nebraska	936	693	598	428	17 450	5 980	19 328	6 312	19 163	6 295
Nevada	526	419	300	257	1 587	520	2 151	556	2 090	539
New Mexico.....	520	292	353	194	7 325	686	7 331	738	7 118	663
North Dakota	368	149	219	83	654	157	816	187	753	183
Oklahoma	575	333	306	175	1 801	474	2 581	512	2 297	503
Oregon	668	565	453	389	10 270	1 587	15 002	1 622	13 214	1 482
South Dakota.....	355	179	246	119	1 517	304	1 674	371	1 618	361
Texas.....	1 000	968	595	652	14 948	5 101	18 784	4 912	17 418	4 842
Utah.....	449	249	302	161	9 185	1 085	10 901	1 143	10 666	1 078
Washington.....	583	496	395	365	10 921	1 435	14 068	1 641	13 042	1 509
Wisconsin	634	274	470	237	1 201	306	2 146	331	1 622	320
Wyoming.....	515	531	376	366	4 588	1 374	5 076	1 465	4 971	1 437

¹Excludes Alaska, Hawaii, and abnormal and horticultural specialty farms.

²Includes 1,039 farms that discontinued irrigation since 1992.

³Includes 18,767 farms that discontinued irrigation since 1992.

was selected.

Estimation

The survey used two types of statistical estimation procedures. These estimation procedures accounted both for selection of the survey sample and for nonresponse to the report form. These procedures were used because not all census irrigators were requested to provide the survey data items and not all irrigators responded to the survey, despite numerous contact attempts. The survey estimates were computed by weighting the data for each respondent irrigator by an expansion factor that was the

product of the whole farm nonresponse weight, the sample weight, and the ratio estimation weight.

The whole farm nonresponse weight was used to expand the survey data to account for the irrigators who did not respond to the survey for whatever reason and for the survey report forms that could not be delivered (post-master returns). For each stratum group, a noninteger nonresponse weight was calculated at the stratum level and assigned to each in-scope respondent record. The noninteger nonresponse weight is the ratio of the total number of in-scope sample cases to the total number of in-scope responding cases within a stratum. The assumption underlying this weighting approach to survey

nonresponse is that in-scope survey respondents and nonrespondents within a stratum constitute a homogeneous population, allowing respondents to represent nonrespondents.

The sample weight expanded the survey data to estimate universe totals as if a complete census of irrigators had been conducted. All respondent survey records received a sample weight. The sample weight, calculated at stratum level, is the ratio of the universe estimated number of in-scope irrigating farms in a stratum to the count of in-scope sample farms, within the same stratum. A third weight, the ratio estimation weight, was used to obtain agreement between survey estimates and census estimates of universe in-scope irrigated acres at publication level within stratum. The final weight, the product of the sample weight, the nonresponse weight, and the ratio estimation weight, was randomly integerized for tabulation. If, for example, the final weight for the number of irrigators in a particular stratum was 7.2, then one-fifth of the irrigators in this stratum were randomly assigned a weight of 8 and the remaining four-fifths received a weight of 7. The survey total for a given characteristic was estimated by multiplying the data value by the corresponding sample farm final weight and summing over all sample farms for respective geographic area.

Survey Error

The statistics in this report are estimates derived from a sample survey. Sampling and nonsampling are two types of errors possible in an estimate based on a sample survey. Sampling errors occur because observations are made only on a sample, not on the entire population. The sample selection, estimation, and nonresponse estimation procedures contribute to the sampling errors. Nonsampling errors exist even in a complete census and can be attributed to such sources as report form design, data processing, survey coverage, and imputation for missing data. Sampling and nonsampling errors are kept to a minimum for the certainty stratum, as the data values were obtained directly from report forms and telephone follow-up. The "accuracy" of a survey result is determined by the joint effects of sampling and nonsampling errors.

Sampling Errors

Variability in the estimates of the survey items was due to the sample selection procedure, the sample estimation procedure, and the nonresponse estimation procedure. Sampling error was estimated by using the random group method of variance estimation. Each responding sample farm in a State was randomly assigned to a random group based on its order of selection. Sixteen random groups were used. Each random group contained the same sample strata as the original sample with the eligible cases allocated to the stratum similar to that of the original sample. An estimate of the total was

computed from each random group and the variation among these random group estimates was used to estimate the overall sampling error. Estimates of sampling variability, expressed as percent relative standard errors (percent), are presented in table D. The survey sample was one of a large number of possible samples of the same size that could have been selected using the same sample design. Estimates derived from the different samples would differ from each other. The difference between a sample estimate and the average of all possible sample estimates is called the sampling deviation. The standard error or sampling error of a survey estimate is a measure of the variation among the estimates from all possible samples, and is a measure of the precision with which an estimate from a particular sample approximates the average result of all possible samples. The percent relative standard error of an estimate is defined as the standard error of the estimate divided by the value being estimated multiplied by 100. If all possible samples were selected, each of the samples were surveyed under essentially the same conditions, and an estimate and its standard error were calculated from each sample, then:

1. Approximately 67 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average value of all possible samples.
2. Approximately 90 percent of the intervals from 1.65 standard errors below the estimate to 1.65 standard errors above the estimate would include the average value of all possible samples.

The computations necessary to construct the above confidence statements are illustrated in the following example. Assume that the estimated number of irrigated acres of a certain item is 669,813 and the relative standard error of the estimate is 1.6 percent (0.016). Multiplying 669,813 by 0.016 yields 10,717, the standard error. Therefore, a 67-percent confidence interval is 659,096 to 680,530 (i.e., 669,813 plus or minus 10,717). If corresponding confidence intervals were constructed for all possible samples of the same size and design, approximately 2 out of 3 (67 percent) of these intervals would contain the figure obtained from a complete enumeration. Similarly, a 90-percent confidence interval is 652,130 to 687,496 (i.e., 669,813 plus or minus 1.65 x 10,717).

Nonsampling Errors

Nonsampling errors arise from incorrect or incomplete data reporting, misinterpretation of questions, imputation of missing data, and inaccurate processing of data. Careful efforts were made to keep errors introduced during clerical and electronic processing to a minimum through the use of quality control, verification, and check measures on specific operations. All such errors are in

Table D. Relative Standard Error (Percent) for Selected Irrigation Data: 1994

Geographic and water resources areas	Irrigated farms	Acres in farms	Acres irrigated				Acre-feet of water applied, all sources	Wells used in 1994	Pumps all types	Expenses for irrigation		
			Total	Cropland harvested	By sprinkler systems	By gravity flow				Energy used for pumping	For wells, pumps, equipment, and facilities	Maintenance and repair
Conterminous United States ...	1.0	3.4	1.0	1.0	1.3	1.8	1.7	2.0	2.3	2.5	3.8	2.0
27 Leading irrigation States	1.0	3.5	1.1	1.1	1.4	1.8	1.7	2.1	2.4	2.5	3.8	1.9
17 Western States	1.2	3.7	1.1	1.2	1.6	2.0	1.7	2.7	3.1	2.7	4.2	2.2
All other States	3.9	5.3	4.1	4.2	4.4	18.4	5.4	8.5	5.4	4.0	9.5	24.1
Arizona.....	10.9	28.2	2.5	2.6	14.4	3.4	2.3	14.3	12.9	7.2	10.2	5.8
Arkansas.....	5.5	5.6	3.2	3.3	12.5	3.5	3.2	4.9	4.3	6.6	13.4	6.6
California.....	2.2	12.1	2.3	2.6	7.5	4.3	3.4	7.5	6.9	6.6	7.6	6.0
Colorado.....	2.8	11.3	3.1	3.6	4.8	4.0	4.3	3.9	21.0	4.7	15.5	7.7
Florida.....	5.2	23.4	3.5	1.9	8.8	8.5	3.4	6.6	5.8	11.6	14.0	4.5
Georgia.....	3.1	5.0	11.6	12.3	12.5	74.1	26.6	11.0	6.9	15.0	20.3	17.6
Idaho.....	2.5	10.2	3.6	3.0	4.9	8.8	4.1	7.9	4.9	5.3	15.2	7.8
Illinois.....	2.9	2.8	1.7	1.7	2.6	57.1	2.4	2.0	2.1	4.0	8.8	5.5
Kansas.....	4.8	4.6	4.9	5.0	6.5	6.0	6.7	4.0	4.2	4.2	12.8	5.4
Louisiana.....	3.4	4.1	3.4	3.5	12.4	5.0	5.2	8.1	7.2	6.5	27.9	6.2
Michigan.....	4.9	4.4	2.9	3.0	3.0	57.6	2.9	15.4	10.2	4.1	6.0	6.6
Minnesota.....	3.8	3.2	1.2	1.3	1.5	5.2	1.4	3.0	2.4	2.3	12.9	9.8
Mississippi.....	3.6	4.0	2.3	2.3	5.1	3.3	3.4	2.6	2.3	2.4	6.4	4.0
Missouri.....	4.8	5.0	2.8	2.8	3.9	2.8	4.1	2.6	2.7	6.0	17.3	6.2
Montana.....	3.3	9.3	3.0	4.1	6.2	5.5	5.5	23.2	8.6	11.2	25.7	5.7
Nebraska.....	2.4	5.8	2.1	2.1	3.3	4.9	3.6	2.5	3.1	4.5	17.1	8.4
Nevada.....	2.9	10.3	2.5	2.6	6.6	3.4	2.0	7.1	6.4	8.1	16.8	6.8
New Mexico.....	5.7	27.9	4.1	4.3	5.9	6.2	6.1	9.6	11.3	8.8	13.1	6.6
North Dakota.....	5.5	11.9	2.9	2.9	3.9	10.6	4.7	4.9	4.8	3.9	7.8	5.5
Oklahoma.....	2.8	6.1	4.2	4.0	4.6	6.2	4.5	5.3	3.7	7.1	12.3	5.7
Oregon.....	5.0	11.4	5.8	7.6	8.6	11.7	4.4	12.9	9.0	11.1	19.6	21.0
South Dakota.....	5.0	11.2	3.3	3.4	3.9	7.1	7.5	7.2	6.7	4.1	21.7	7.1
Texas.....	3.2	8.4	4.7	5.1	3.3	8.4	6.3	5.8	5.5	5.5	10.5	4.1
Utah.....	3.8	32.5	3.8	4.3	9.9	5.7	7.9	20.1	18.2	7.9	16.6	10.6
Washington.....	7.9	16.1	2.7	2.8	3.7	6.2	4.2	13.6	7.7	3.8	24.6	9.3
Wisconsin.....	3.1	2.7	1.3	1.3	1.3	20.8	3.0	2.5	3.3	3.7	15.7	5.0
Wyoming.....	6.2	17.1	3.5	2.3	9.8	4.0	5.0	25.2	19.9	8.1	24.6	6.8
WATER RESOURCES AREAS												
WRA 01 New England.....	4.1	6.4	2.7	2.9	2.5	4.1	4.6	22.0	7.1	3.8	7.5	4.0
WRA 02 Mid-Atlantic.....	6.1	10.3	4.3	4.4	4.7	23.3	8.9	10.8	8.4	9.1	12.9	47.3
WRA 03 South Atlantic-Gulf.....	3.6	10.9	3.9	3.5	8.0	8.4	4.0	5.1	3.8	8.1	10.9	4.1
WRA 04 Great Lakes.....	4.3	3.1	1.9	2.0	2.0	26.2	2.1	11.5	7.8	2.7	5.1	5.0
WRA 05 Ohio.....	7.6	4.5	1.4	1.4	1.5	16.8	1.6	12.4	7.4	1.8	13.5	7.1
WRA 06 Tennessee.....	18.1	9.0	2.9	2.3	3.4	68.3	7.5	26.8	18.3	2.8	4.7	10.2
WRA 07 Upper Mississippi.....	1.7	2.6	1.0	1.0	1.4	12.5	1.4	1.9	1.8	1.9	10.4	2.3
WRA 08 Lower Mississippi.....	3.9	2.1	2.7	2.6	5.0	4.0	2.8	4.0	3.5	5.4	8.9	4.4
WRA 09 Souris-Red-Rainy.....	7.4	7.9	4.0	4.0	5.1	12.7	3.9	6.5	5.5	4.4	6.3	5.8
WRA 10 Missouri.....	1.6	6.8	1.3	1.3	2.2	2.1	1.4	2.0	5.7	2.6	6.7	4.5
WRA 11 Arkansas-White-Red.....	3.6	7.9	3.2	3.3	4.1	5.3	3.9	4.1	3.9	3.9	8.6	5.0
WRA 12 Texas-Gulf.....	4.8	7.8	5.6	5.8	5.0	11.1	9.3	9.7	8.9	8.2	14.1	7.3
WRA 13 Rio Grande.....	6.7	27.5	3.7	4.2	9.8	6.6	5.5	8.0	7.7	8.1	13.7	5.3
WRA 14 Upper Colorado.....	6.2	23.1	5.8	6.1	12.5	7.2	7.7	50.7	17.8	23.4	26.5	11.4
WRA 15 Lower Colorado.....	9.5	25.9	2.9	2.6	12.1	3.5	2.5	11.9	11.1	6.9	9.4	6.2
WRA 16 Great Basin.....	3.8	14.9	4.0	2.8	6.2	6.4	3.7	11.1	14.2	7.1	13.8	8.7
WRA 17 Pacific Northwest.....	3.0	7.6	2.7	2.5	3.3	6.2	2.3	6.0	3.5	3.6	13.6	4.5
WRA 18 California.....	2.3	12.2	2.5	2.7	7.6	5.3	3.8	7.8	6.6	6.2	10.0	7.8

addition to sampling errors and are independent of the sample design.

Some data reported may be incorrect as a result of the misinterpretation of a question or because of the use of estimates in reporting. Respondents may have failed to provide all of the information requested. In some cases, the respondent may have indicated the presence of an item but not the amount. Data were reviewed for inconsistencies. Changes were made to data items which appeared to be inconsistent with other items. Imputations were made for missing data on acres irrigated, quantity of water used, method of water distribution, quantities of crops harvested, maintenance and repair costs, cost of water received from off-farm water suppliers, and depths, capacities, and energy cost of well pumps. If a respondent discontinued irrigation, no imputations were made for expenditures on irrigation facilities, method of deciding when to apply water, and other irrigation uses on the place such as the application of fertilizer, chemicals, or water to prevent freeze damage.

QUALIFICATIONS OF THE DATA

Analysts reviewing the returned report forms and results of the computer edit detected a few inquiries which were not uniformly interpreted by all respondents. Data users should be aware that respondent interpretation of some inquiries may affect the final results in their use of these selected statistics. Clarification of data items with potential extortions and data impacted by unique problems or definitions are provided as follows.

Irrigated land—Irrigated land is defined as “all land watered by artificial or controlled means.” No attempt has been made to define the degree or intensity of irrigation. Therefore, the figures for irrigated land include land with as little as 1 inch of water applied as well as land having several feet of water applied.

Nonirrigated crop yields—Data users are reminded that the nonirrigated crop yield averages in table 22 are for nonirrigated crops harvested from farms having land irrigated and may not be comparable with crop yield averages for nonirrigated farms.

Estimated quantity of water applied—Most water used for irrigation is not metered or measured accurately. Therefore, the quantity of water data are on the basis of best estimates provided by irrigators. Generally, in areas of water scarcity such as Southern California and Arizona, irrigators are more likely to be able to provide quantities of water used than in Mountain States such as Montana, Wyoming, and Idaho where scarcity of water is less of a problem. Furthermore, in the Mountain States where water from snow melt is diverted for use in season, the amount of water used may at best be a rough estimate, seldom a measured figure.

Application of commercial fertilizers or pesticides in irrigation water—This inquiry was intended to measure the number of farms adding or mixing fertilizer and pesticides to irrigation water as it was being conveyed or distributed to the crop. The tabulated results may overstate this practice because some irrigators have misinterpreted the inquiry to include conventional application of fertilizer and pesticides to the irrigated crop as well as applying chemicals directly into the irrigation water, which carries them to the crop.

Cost of water received from off-farm water suppliers—Irrigators receiving water from off-farm water suppliers are generally required to pay for the water in charges, fees, or assessments. The dollar amount for cost of water was one of the more frequently omitted items on the report form. Computer edit procedures called for imputing an estimate for cost of water based on other reports from the same geographic area. At the national level 15 percent of the farms reporting cost and 13 percent of the total dollar amount was imputed.

Irrigation wells—Some farm operators reported wells used only for domestic purposes or livestock as wells “not used” in 1994, meaning not used for irrigation. Where identified for domestic purposes or livestock use, the entry was deleted. Data users are reminded that there are additional wells reported as not used in 1994, but capable of being used, which may be for domestic purposes or livestock use only.

Artesian or free flowing wells—A specific entry space was not provided for artesian wells. During processing, all wells which were indicated to be free flowing or artesian were removed from the pumped well section and tabulated as free flowing or artesian wells. The data for well pumps excludes any pumps which may have actually been used to pump water from artesian wells.

Irrigation pumps—The inventory figures for number of irrigation pumps on farms reported in table 14 include reserve pumps not actually used in 1994, but exclude any pumps on wells not used in 1994. By definition, flowing or artesian wells do not have well pumps.

Expenditures for maintenance and repair and investment in irrigation facilities and equipment—The expenditure data reported are expenditures that occurred only in 1994.

Some respondents found it difficult to separate expenditures for maintenance and repairs from investment in irrigation facilities and equipment as defined on the report form. For example, replacement of worn out sprinkler nozzles, pumps, and motors could be considered either as repair cost or investment in new equipment. Therefore, data users are reminded that the distinction between the two expenditure categories is blurred for some respondents.

Government programs—This question was not asked in previous irrigation surveys. Where the respondent left the response blank, a “yes” entry was imputed if there were federal payments received in 1992.

Improvements to irrigation systems that reduce energy and/or conserve water used in irrigation—This question was not asked in previous irrigation surveys. Respondents were asked to respond for the period covering the last 5 years. The information for this item was tabulated as reported. No imputation was made for a blank response.

Sources of irrigation information—This question was not asked in previous irrigation surveys. The information for this item was tabulated as reported. No imputation was made for a blank response.

Reason for discontinuance of irrigation since 1992—The data shown in table 35 reflect the expansion of reported entries. Some respondents reported multiple reasons while others gave no specific reason for discontinuance.

SUMMARY AND CONCLUSIONS

Irrigated Crops

The principal crop irrigated in the conterminous United States in 1994, according to results of the 1994 Farm and Ranch Irrigation Survey, was corn for grain or seed with 9.4 million acres. Others were alfalfa hay with 5.3 million acres, cotton with 4.4 million acres, orchard land with 3.6 million acres, and wheat with 3.4 million acres. These five irrigated crops accounted for 61 percent of the acreage of all irrigated crops. The average irrigated yields were 158 bushels of corn per acre, 4.8 tons of alfalfa hay per acre, 933 pounds of lint per acre of cotton, and 70 bushels of wheat per acre.

Total land irrigated by 198,115 irrigators included in the 1994 survey was 46.4 million acres. The leading State in total acreage of irrigated land is California with 7.3 million acres, followed by Nebraska with 6.0 million acres, and Texas with 5.1 million acres.

Method of Irrigation

There were 46.4 million acres irrigated by different water distribution systems in 1994. Approximately 2.2 million acres were irrigated by more than 1 of the 13 distribution systems listed on the report form. Of the total acres irrigated by all types of distribution systems, 25.1 million acres were irrigated by gravity flow systems and 21.5 million acres by sprinkler systems.

Sprinkler systems were used to irrigate 46 percent of the total land irrigated in 1994 compared with 40 percent in 1988, and approximately 38 percent in 1984 and 1979.

Gravity flow systems were used on 54 percent of the land in 1994, compared to significantly higher percentages in 1988, 1984, and 1979.

Of the 21.5 million acres irrigated by sprinkler systems, center pivot medium pressure systems (30 to 59 psi) were used to irrigate 5.9 million acres and center pivot low pressure systems (under 30 psi) were used to irrigate 5.7 million acres. Next were center pivot high pressure systems (60 psi or greater) with 3.2 million acres, and linear and wheel move systems with 3.0 million acres. Hand move systems accounted for 1.9 million acres.

Estimated Quantity of Water Applied

Irrigators estimated that a total of 79.6 million acre-feet of water was applied to the 46.4 million acres irrigated in 1994 in the conterminous United States for an average of 1.7 acre-feet per acre irrigated. Table E shows the average acre-feet of water applied per irrigated acre over the last 25 years. The average amount of water applied per acre in the 27 leading irrigating States ranged from a high of 4.4 acre-feet in Arizona to a low of less than one foot per acre in eight other States. The average for the remaining 21 Eastern States was 0.7 acre-feet.

Table E. **Average Acre-Feet of Water Applied Per Irrigated Acre**

Year and source	Amount applied
1994 Farm and Ranch Irrigation Survey	1.72
1988 Farm and Ranch Irrigation Survey	1.82
1984 Farm and Ranch Irrigation Survey	1.80
1979 Farm and Ranch Irrigation Survey	1.86
1974 Census of Agriculture	2.09
1969 Census of Agriculture	2.11

Special tabulations of data for farms having only one of the four kinds of distribution systems--sprinklers, gravity, drip, or subirrigation--show noticeable differences in the amount of water applied per acre by each system. For example, farms using only sprinkler systems applied 1.2 acre-feet per acre irrigated compared with 2.0 acre-feet for farms using only gravity flow systems (see table 7).

For the conterminous United States, results of the survey show that on rice, alfalfa hay, land in vegetables, and land in orchards farmers applied heavy amounts of water averaging over 2.0 acre-feet per acre irrigated while on corn for grain, wheat, cotton, barley, Irish potatoes, and other hay amounts between 1.0 and 2.0 acre-feet were applied. Soybeans, peanuts, and tobacco had less than 1.0 acre-feet of water applied per acre irrigated.

Source of Water

There was a total of 46.4 million acres irrigated by water from all sources in 1994. Approximately 11.3 million acres were irrigated with water from more than one of the three sources listed on the report form. About 28.8 million acres (62 percent) were irrigated from farm irrigation wells, 13.9 million acres (30 percent) from off-farm water suppliers, and 6.0 million acres (13 percent) from on-farm surface sources.

Of the estimated 79.6 million acre-feet of water used for irrigation in 1994, 39.4 million acre-feet (49 percent) were pumped from wells, 31.6 million acre-feet (40 percent) were provided by off-farm water suppliers, and the other 8.6 million acre-feet came from on-farm surface sources. Table F shows how these data correspond to previous farm and ranch irrigation surveys.

Table F. **Irrigation Water Used by Source: 1994, 1988, 1984, and 1979**

Farm	1994	1988	1984	1979
Total	79.6	84.1	82.7	93.1
Wells:				
Acre-feet (millions)	39.4	40.5	36.2	43.2
Percent.....	49	48	44	47
On farm:				
Acre-feet (millions)	8.6	8.9	10.2	8.8
Percent.....	11	11	12	10
Off farm:				
Acre-feet (millions)	31.6	34.9	36.2	41.0
Percent.....	40	41	44	44

The average amount of water applied per acre varied significantly by source. Land irrigated from wells averaged 1.4 acre-feet applied per acre. Land irrigated from off-farm water suppliers averaged 2.3 acre-feet applied per acre. Sprinkler irrigation systems were more closely related to the distribution of well water than gravity flow systems which were generally used to distribute water from off-farm water suppliers. However, for purposes of water economy and efficiency of water use, the trend by irrigators has been toward greater use of sprinkler systems over the past decade.

Irrigation Wells

There were 363,237 irrigation wells capable of being used on 109,450 farms. Of these wells, 329,123 were pumped in 1994, 33,384 were idle, and 730 were artesian or free flowing. The 329,853 irrigation wells used supplied 39.4 million acre-feet of water to 26.8 million acres of land, averaging 119.5 acre feet per well and 87.4 acres irrigated per well. Farms with wells used in 1994 averaged 3.1 wells per farm. Over 66 percent of the

farms using wells in 1994 used one or two wells, but the majority of wells used (58 percent) were on the 20,372 farms using five or more wells per farm, indicating the impact of the large irrigators on statistics. For the conterminous United States, pumped wells averaged 239 feet in well depth, 143 feet in pumping depth, and 831 gallons per minute in pumping capacity.

Of the 329,853 wells in use, 55,839 farms reported that 205,083 (62 percent) had back-flow-prevention devices installed. There were 46,526 wells with meters on 15,688 farms.

Irrigation Expenditures

Pumping costs—There was a total of 469,972 irrigation pumps of all kinds used on 137,845 farms in 1994 to irrigate 35.9 million acres of land. These pumps were powered by fuels and electricity costing irrigators a total of \$1,208 million, an average of \$8,764 per farm or \$34 per acre irrigated. The principal power source was electricity, for which \$820 million was spent to power 279,101 pumps and irrigate 19.8 million acres at an average cost of \$41 per acre. Natural gas cost irrigators \$190 million to power 50,836 pumps and irrigate 6.1 million acres at an average cost of \$31 per acre. Diesel fuel cost \$167 million to power 81,737 pumps and irrigate 8.2 million acres at an average cost of \$20 per acre. Table 17 presents more information on the other fuels used to power irrigation pumps.

Cost of water from off-farm water suppliers—There were 85,083 farms who reported using 31.6 million acre-feet of water from off-farm water suppliers to irrigate 13.9 million acres at an average cost of \$15.66 per acre-foot of water or \$35.58 per acre irrigated. Included in the 85,083 farms are 3,674 farms that indicated that they irrigated 829,988 acres with 1,846,592 acre-feet of water that they received at no cost.

Maintenance and repair cost—Expenditures for maintenance and repairs totaled \$433 million on 134,689 farms for an average of \$3,212 per farm or \$10.66 per acre irrigated.

Investment in irrigation equipment, facilities, and land improvement—Investment in irrigation equipment, facilities, and land improvement in 1994 totaled \$798 million for an average of \$9,896 per farm. The principal investment was in the purchase of irrigation equipment and machinery, which totaled \$573 million and represented 72 percent of total investment. The next three categories were \$92 million (12 percent) spent for new well construction and well deepening, \$82 million (10 percent) spent for construction of permanent storage and distribution systems, and \$51 million (6 percent) spent for land clearing and leveling.

Discontinuance of Irrigation in 1994

An estimated 18,787 operations, who had irrigated a total of 1.6 million acres according to the 1992 Census of Agriculture, did not irrigate in 1994. The majority (80 percent) of these operators reported that their discontinuance was not permanent.

Land Laser Leveled for Irrigation

An estimated 23,356 farmers reported that they had 5.3 million acres of land that had been laser leveled for irrigation purposes. This was an increase of 2.3 million

acres of land from the 1988 Farm and Ranch Irrigation Survey.

Improvements to Irrigation Systems

More than 27.1 million acres irrigated were reported to have had improvements made on them to reduce energy or conserve water. These improvements resulted in reduced water requirements on 18.5 million acres irrigated, improved crop yield on 15.8 million acres irrigated, and decreased energy costs on 15.3 million acres irrigated. Table 32 presents more information concerning the results of improvements made to irrigation systems in the last five years.