Oklahoma Cooperative Extension Service BAE-1530

# Irrigated Agriculture in Oklahoma

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## Introduction

Irrigation plays a vital role in fostering the economic viability of agricultural production in Oklahoma, especially in the arid/semi-arid western parts of the state. In recent years, irrigated agriculture has suffered from prolonged droughts and faced strong competition from industrial, urban and environmental sectors. These constraints, along with the increasing demand in food, feed, fiber and fuel necessitate the urgent need to provide Oklahoma producers with information to improve irrigation management and maximize water productivity. This task, however, is not possible without understanding the current situation and investigating potential weaknesses and opportunities.

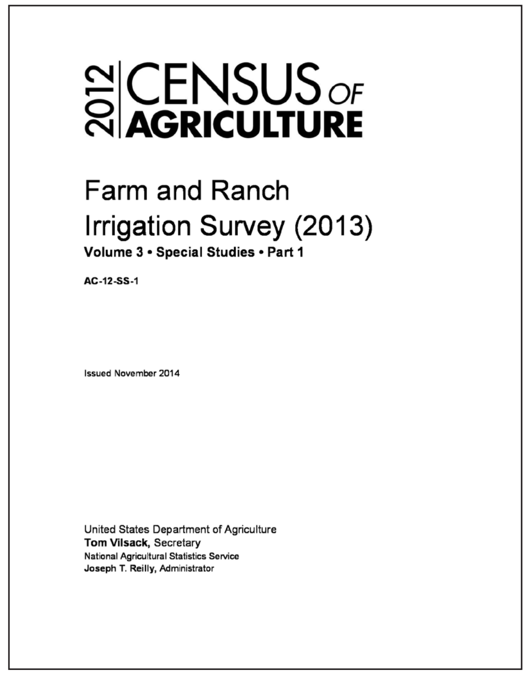
This fact sheet provides a comprehensive picture of the state of irrigated agriculture in Oklahoma. The information and analysis are based on data published in the Farm and Ranch Irrigation Survey conducted in 2013 by the National Agricultural Statistics Service of the United States Department of Agriculture (USDA).

## Farm and Ranch Irrigation Survey 2013

The 2013 Farm and Ranch Irrigation Survey (FRIS) adds detailed irrigation-related information to the basic data collected from all agricultural operations in the 2012 Census of Agriculture. Although FRIS was conducted in 1997, 2003 and 2008 too; the 2013 data are not comparable with previous FRIS reports at the state level, since horticultural operations were combined with agricultural operations in the 2013 data. As a result, comparisons made in this fact sheet are limited to specific commodity crops and relative data to avoid misleading conclusions.

Some of the tables in the FRIS 2013 provide separate data for crops grown in the open and grown under protection (e.g. greenhouses). This fact sheet covers both types of operations whenever possible. In some occurrences however, data are reported only for operations in the open. Under protection operations account for a small fraction of all operations in Oklahoma and mainly belong to horticultural products. Thus, excluding them from some analysis has minimal impact on investigating the status of irrigated agriculture. Oklahoma data presented in FRIS 2013 are based on processed survey results collected from 314 farms in the state, representing more than 200,000 acres of irrigated lands.

FRIS 2013 also reported the relative standard errors (RSE) for general irrigation data. For Oklahoma, the RSE was 6.4 percent for irrigated farms, 7.0 percent for the quantity of applied water, 7.1 percent for irrigated acres and pumps, 8.3 percent for energy expenses and 11.2 percent for other expenditures. The RSE is an indicator of the precision of survey parameters and can be used to construct confidence intervals. For example, if the quantity of applied water was 100,000 acre-feet with a RSE of 7 percent, the 67 percent confidence interval is from 93,000 to 107,000 (100,000 ± 100,000 × 0.07). In order words, the true value of applied water quantity lies in the estimated interval with 67 percent confidence.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United States Department of Agriculture
Tom Vilsack, Secretary
National Agricultural Statistics Service
Joseph T. Reilly, Administrator

**Figure 1. FRIS 2013 cover page.**

## General Information

According to FRIS 2013, Oklahoma has 1,672 farms containing irrigated lands. The total area of land in these farms exceeds 2.5 million acres, with an actual irrigated area of 426,602 acres. This shows an 8 percent decrease compared to the total irrigated acres in FRIS 2008, despite the fact that irrigated horticultural operations were not included in 2008 estimates. In terms of actual irrigated acres, Oklahoma is ranked 26th among all 50 states. All of our neighboring states

**Figure 2. Lake Altus, photo taken on October 3, 2014.**

have significantly larger irrigated acres, ranging from New Mexico with about 700,000 acres (ranked 19th) to Arkansas with 4.95 million acres (ranked 3rd).

The total amount of irrigation water applied in the survey year was 522,454 acre-feet, which is equal to more than 170 billion gallons. Less than 0.1 percent of this amount was applied to operations under protection and the remaining (99.9 percent) was applied to operations in the open. The total amount of applied water shows only a small decrease (less than half a percent) compared to 2008 estimate of 524,675 acre-feet. However, 92 percent of the total water applied in the open in 2013 was supplied from groundwater resources and the remaining 8 percent from surface resources. This shows a greater reliance on groundwater compared to 2008 data, when 83 percent of total applied water was withdrawn from state aquifers. Recent droughts in southwestern parts of the state and the consequent decline in surface water resources could be a possible reason behind the increase in groundwater extraction. It should be noted that the reported amount of applied water is based on irrigators' best estimate and not metered flow rates. Hence, these estimates usually have a higher degree of uncertainty.

Reclaimed water, defined as the wastewater that has been treated for non-potable reuse purposes, could be an important source of water when freshwater resources are scarce. In 2013, only 18 farms in Oklahoma reported the use of reclaimed water for irrigation. The total irrigated area in these farms was 2,205 acres, accounting for about half a percent of all irrigated acres in the state. This shows a decrease compared to 3,775 acres that reported use of reclaimed water in 2008.

## Irrigation Wells

According to FRIS report 4,912 irrigation wells were in use on Oklahoma irrigated lands in 2013. Only 16 percent of these wells had meters to monitor groundwater withdrawal. In addition, 29 percent of wells did not have a backflow prevention device, which is necessary to prevent the flow of potential contaminants into aquifers; especially if chemigation is practiced. Chemigation is the injection of chemicals such as fertilizers and pesticides into irrigation systems.

The 2013 average well depth was 219 feet in Oklahoma, similar to the average value for Kansas and less than the average depth for Texas (276 feet). The average depth to water estimated at the beginning of the growing season was 84 feet in Oklahoma. The water table in Oklahoma is closer to the surface on average than in Kansas and Texas with 103 and 146 feet of depth to water, respectively. Compared to 2008 survey, only 12 percent of Oklahoma wells showed an increase in depth to water, while 57 percent reported no change. However, the 2013 average pumping capacity was 408 gallons per minute (gpm), significantly less than the 2008 average of 505 gpm. This was also less than the 2013 average pumping capacity in Kansas (605 gpm), but about two times larger than the value for Texas (208 gpm). The national average in 2013 was 722 gpm.

## Irrigation Pumps and Energy Costs

Regardless of water source (surface or ground), a large number of irrigated farms rely on pumps to either raise the water to a desired level or to pressurize it for distribution through sprinkler and drip systems. In 2013, Oklahoma producers spent more than $22 million in energy expenses to power 5,351 pumps. Taking irrigated acres into account, this amount of energy expenditure translates into $52 and $17 per acre for groundwater and surface water irrigation, respectively. Electricity was the main source of pumping energy, supplying water to 46 percent of all irrigated acres in state. This was followed by natural gas and diesel, which powered pumps to irrigate the 42 percent and 11 percent of the remaining irrigated acres, respectively. All other sources of energy such as LP gas, propane, butane, ethanol, etc. were used on only 1 percent of irrigated lands.

## Other Irrigation-Related Expenditures

In addition to the energy expenses mentioned above, Oklahoma producers spent another $18.8 million on irrigation equipment, facilities, land improvement, and computer technology. A large portion of this money (44 percent) was spent for scheduled replacement and maintenance. About one-third (33 percent) of the total expenditures was dedicated to new expansion. Only 18 percent was used for water conservation, less than the portion of Arkansas expenditure (24 percent) and the national average (20 percent) but more than portions of expenditure in Kansas (9 percent) and Texas (16%). The

**Figure 3. An electric pump discharges groundwater into an irrigation ditch.**

remaining 5 percent of expenditures in Oklahoma were used for energy conservation. The statistics presented here show the potential for increasing investments in water and energy conservation practices. Only 3 percent of irrigated acres where expenditures were made received funding assistance from EQIP or other USDA programs.

## Irrigation Interruption

Out of all irrigated acres in Oklahoma, 73,428 acres experienced an irrigation interruption in 2013 that resulted in diminished crop yield. The leading cause for irrigation interruption was equipment failure, affecting 61 percent of all acres reporting interruption. This cause was followed by groundwater shortage and surface water shortage, in that order.

## Deciding When to Irrigate

Improving irrigation management is not possible without implementing state-of-the-art methods in deciding when to irrigate. In Oklahoma, the main method for determining irrigation timing was the "condition of crop" in 2013, mentioned by 88 percent of irrigators. The next most common method was the "feel of soil," used by 39 percent of all irrigators. The third most common method was based on "calendar," implemented in 20 percent of all farms. Making decisions based on the data collected by soil and plant sensors were ranked forth, with only 11 percent of irrigators reporting to have implemented this approach. The percentage of farms that used sensors was similar in Kansas (12 percent), Texas (11 percent), and the U.S. on average (11 percent), but significantly larger for California (22 percent) and Nebraska (23 percent).

Despite the availability of the Oklahoma Mesonet as an extensive and well-maintained network of weather stations, the use of daily evapotranspiration (ET) products in determining when to irrigate was reported by only 8 percent of Oklahoma farmers. This is similar to the U.S. average and to many other states that do not have extensive weather station networks. The percentages were higher for Kansas and Nebraska, with 17 percent and 24 percent of farmers using daily ET products, respectively. Another modern approach to determine irrigation timing is the use of computer simulation models, which was reported by a single farm in Oklahoma. The above information suggests there is a great potential to improve irrigation scheduling in Oklahoma by promoting the use of advanced approaches such as sensors, Mesonet products, and computer models. It should be noted that percentages reported for mentioned methods do not add up to 100 percent, since many irrigators use more than one method to decide about irrigation timing.

**Figure 4. Installing soil moisture sensors at a cotton field near Altus, OK.**

## Barriers toward Water and Energy Conservation

Identifying the barriers that prevent producers from improving water and energy conservation is the first step toward achieving conservation goals. The leading barrier in 2013 was related to cost effectiveness. Thirty-eight percent of producers mentioned that improvements would not reduce costs enough to cover installation costs. Only 17 percent of farmers mentioned this factor as a barrier in 2008. Two other economic factors were among the top barriers in 2013, with 26 percent of farmers stating that they cannot finance improvements and 27 percent indicating that landlords would not share in costs. Uncertainty about the future of water availability and the risk of reduced crop yields were among the next most important barriers. Nineteen percent of producers mentioned that water and energy conservation was simply not their priority, which shows a positive decline when compared to 29 percent in 2008.

## Sources of Irrigation Information

The most relied upon source of irrigation information in the state was university specialists and Extension agents, mentioned by about half of all irrigated farms in FRIS 2013. Irrigation equipment dealers and private irrigation specialists were the next two sources, each mentioned by one-third of irrigated farms. These two sources were mostly used by

**Figure 5. A field day at the Panhandle Research and Extension Center, where irrigation studies are being conducted on corn and sorghum.**

producers with larger irrigated acres. Federal and state agencies were indicated as the source of information by less than one-fifth of irrigated farms.

## Irrigation Systems

For operations in the open (excluding the small portion of operations under protection), center pivot sprinkler systems were the most common type of irrigation system in Oklahoma. In 2013, the total area of farmland with center pivot systems was 412,333 acres. Only 1 percent of these farms were under high-pressure (60 psi or more) center pivot systems. These systems are those with an impact sprinkler placed on the mainline, shooting water at an upward angle across long distances (50 feet to 100 feet). High pressure systems have a much larger energy requirement. In addition, from one-fourth to more than one-third of discharged water could be lost due to droplet evaporation and wind drift. According to FRIS 2013, the majority of Oklahoma center pivots (70 percent) run on pressures less than 30 psi. These systems are equipped with drop hoses and low-pressure spray applicators placed within 5 feet to 6 feet above the ground surface.

In 2013, only 14,000 irrigated acres were under gravity (flood) irrigation systems. This indicates a significant decrease compared to more than 67,700 irrigated acres in 2008, despite the fact that 2008 data did not include horticultural operations. The decline may be attributed to prolonged droughts in southwestern Oklahoma and the inability of Lake Altus to deliver irrigation water to large areas of gravity-irrigated farmlands. The most common subtype was furrow systems, occupying 81 percent of all gravity-irrigated lands. Drip and localized irrigation systems (the third major type of irrigation systems along with sprinkler and gravity) occupied only 7,747 acres of irrigated lands.

## Crops Harvested from Irrigated Farms

FRIS 2013 provides detailed information on major irrigated crops in the state. The crop-specific information is comparable among survey years since it is not impacted by inclusion/exclusion of horticultural operations. In 2013, the largest irrigated crop was grain corn, occupying 100,185 acres of irrigated lands. This shows 5 percent and 10 percent increase in irrigated area compared to 2008 and 2003 survey years, respectively. The second largest irrigated crop in 2013 was wheat (for grain or seed), accounting for 96,948 acres of irrigated farmlands. Unlike corn, irrigated wheat shows a significant decline compared to irrigated acres in 2008 and 2003. Irrigated cotton also experienced a considerable decline, being reduced to less than half of about 60,000 acres irrigated in 2008 and 2003. A crop that shows consistent increase in irrigated areas since 2003 is soybean (for beans), which reached a total irrigated area of 31,469 in 2013. Irrigated acres for major commodity crops are presented in Table 1 for the three survey years of 2003, 2008 and 2013.

**Figure 6. A low pressure center pivot system in southwestern Oklahoma.**

**Table 1. Harvested irrigated acres of major crops in Oklahoma.**

| *Crop* | *2013* | *2008* | *2003* |
|---|---|---|---|
| Corn (grain/seed) | 100,185 | 95,182 | 91,178 |
| Corn (silage) | 20,517 | 12,665 | 14,633 |
| Sorghum (grain/seed) | 20,030 | 26,832 | 27,770 |
| Wheat (grain/seed) | 96,948 | 147,489 | 131,691 |
| Soybeans (beans) | 31,469 | 23,793 | 13,563 |
| Alfalfa and mixtures | 17,689 | 21,698 | 37,928 |
| Other hay | 40,701 | 34,981 | 37,697 |
| Peanuts | 10,231 | 9,020 | 26,616 |
| Cotton | 26,436 | 60,033 | 59,588 |

Figure 7 presents a bar chart of the ratio of average yield from irrigated farms to that of dryland operations reported for the major crops of the State. Grain sorghum had the largest ratio of 3.4, with average irrigated and dryland yields of 81 and 24 bu/ac, respectively. This was followed by hay crops other than alfalfa, with a yield that was three times larger at irrigated operations (5.4 tons/ac) than dryland fields (1.8 tons/ac). Cotton yield ratio (2.4) was the third largest, with irrigated yield of 1,030 lb lint/ac compared to 429 lb lint/ac for non-irrigated. The yield ratio for grain corn was 1.8 based on irrigated and dryland average yields of 209 and 114 bu/ac, respectively. The smallest ratio belonged to peanuts, with similar average irrigated and dryland yields of 4,066 and 4,034 lb/ac, respectively (ratio of one). In interpreting yield ratios, it should be noted that 2013 annual precipitation at different parts of the state was either equal or slightly below normal precipitation. Thus, these ratios would have been larger in drought years such as 2011 and 2012. The information presented in Figure 7 can be combined with economic data and analysis to identify if the increased yield justifies the additional costs of purchasing and maintaining an irrigation system.

## Horticultural Operations

Tables 40 to 45 in FRIS 2013 present information about irrigated horticultural operations. In Oklahoma, the total irrigated horticultural area was 22,097 acres in 2013. About 81 percent of this area (17,838 acres) was dedicated to sod production in the open. Nursery crops were next in the row, with 3,660 irrigated acres. About 96 percent of nursery irrigated acres were in the open and the remaining 4 percent under protection. The third largest irrigated area belonged to floriculture and bedding crops with 299 irrigated acres.

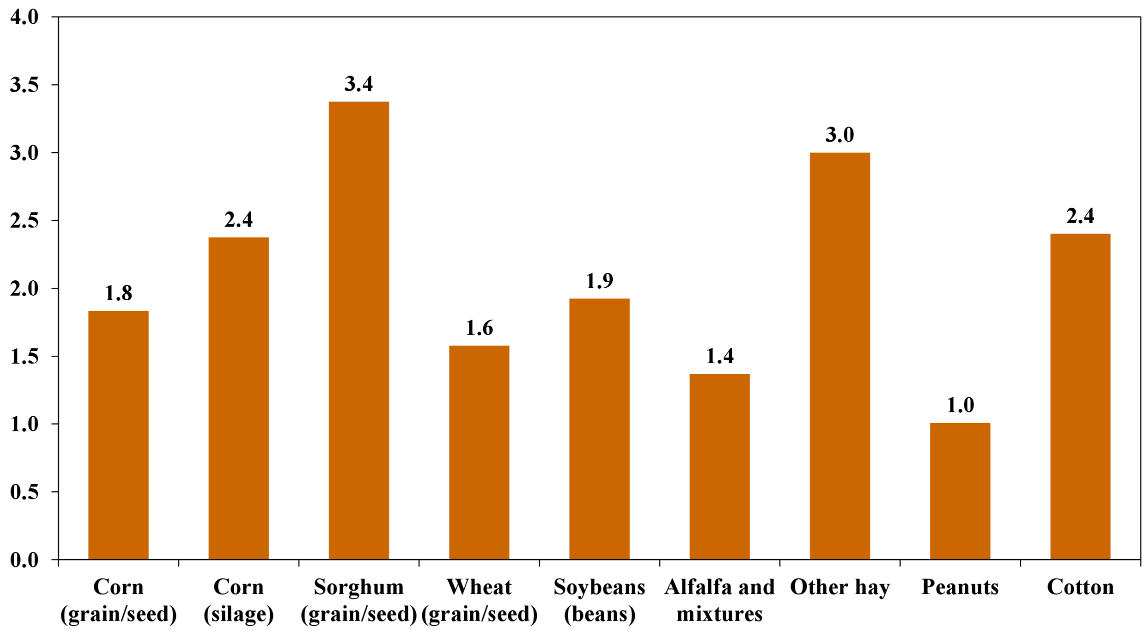


**Figure 7. Ratio of irrigated to dryland average yield based on FRIS 2013 data.**

Christmas trees and woody crops ranked forth, with a total of 261 irrigated acres.

In 2013, about 110 million gallons of irrigation water was applied to horticultural crops under protection. A large portion of this water (87 percent) was applied through sprinkler irrigation systems. Three percent was applied through drip, trickle, or low-flow micro irrigation and the remaining was applied by gravity (flood) systems and hand watering.

The amount of water applied to horticultural operations in the open was much larger at about 6.9 billion gallons. Similar to operations under protection sprinkler systems were the most dominant type of systems, accounting for 91 percent of all application volume. Drip, trickle or low-flow micro irrigation systems were used to apply a large portion of the remaining 9 percent, with gravity systems accounting for less than 1 percent of the applied irrigation water. Groundwater was the major source of water for horticultural operations, with 90 percent of total water being extracted from state aquifers. This shows a strong reliance of horticulture industry on groundwater resources, highlighting the need to better manage this largely nonrenewable resource. The remaining 10 percent of applied water was supplied from on-farm (4 percent) and off-farm (6 percent) surface water resources.

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The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

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- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.



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