

and drip or localized. Each category has several subtypes. For operations in the open, sprinkler irrigation remained the most common type of irrigation system in Oklahoma in 2018, occupying 87% of all irrigated acres. Within different types of sprinkler systems, center pivots were the most widely used, accounting for 93% of all sprinkler irrigated acres. Only 2% of center pivots were operating on high pressures (60 psi or more). These systems are those with impact sprinklers placed on the mainline, shooting water at an upward angle across long distances (50 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. About two-thirds of center pivots in Oklahoma were operating on pressures under 30 psi.

In 2018, about 69,650 irrigated acres were under gravity (flood) irrigation systems. This indicates a significant increase compared to 14,000 acres in 2013. The smaller gravity-irrigated acres in 2013 can be attributed to prolonged droughts in southwestern Oklahoma and the inability of the Lake Altus to deliver irrigation water to large areas of irrigated farmlands. The 2008 estimate of gravity irrigated area in Oklahoma was 67,700 acres, which is closer to the 2018 estimate. The most common subtype in 2018 was furrow systems, occupying 88% of all gravity-irrigated lands. Producers have been applying various water management practices to improve gravity systems over the years. In 2018, about 28% of gravity-irrigated land was under tail water pits, diking, time limits or alternative row irrigation management practices. The precision leveling or zero-grading practices were also implemented in 13% of gravity irrigated acres. These management practices were significantly increased compared to 2013.

Drip and localized irrigation systems (the third major type of irrigation systems along with sprinkler and gravity) occupied only 11,492 acres of irrigated lands in 2018. This shows only a small increase compared to 2008, when 11,239 acres of irrigated land were under this type of irrigation system. More than half of drip-irrigated acres in 2018 were under sub-surface drip and about a third of them were under low-flow micro-sprinklers.



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

Crops Harvested from Irrigated Farms

The 2018 survey 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 2018, the largest irrigated crop was grain corn, occupying about 131,000 acres of irrigated lands. This shows a consistent increase in irrigated area compared to the past three surveys conducted in 2013, 2008 and 2003. The second largest irrigated crop in 2018 was wheat for grain or seed, accounting for about 104,000 acres of irrigated farmlands. Irrigated wheat area was up by 7% compared to 2013, but smaller than 2008 and 2003 acres. Irrigated cotton experienced a significant increase, going from about 60,000 irrigated acres in 2003 and 2008 to about 114,000 acres in 2018. Soybeans for beans also shows consistent increase in irrigated area, from 13,500 acres in 2003 to more than 62,000 acres in 2018. The changes in irrigated acres of the top five commodity crops with time are shown in Figure 7.

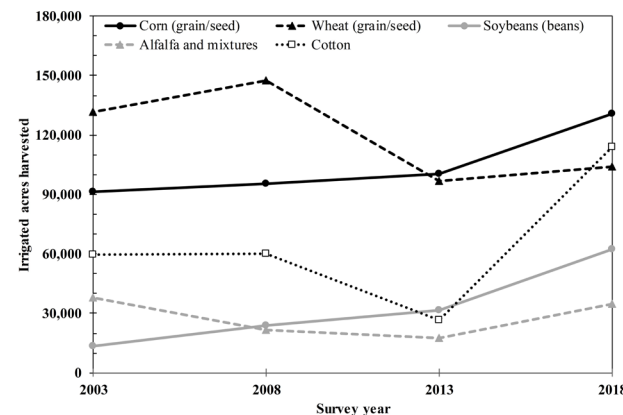


Figure 7. Harvested irrigated acres of major crops in Oklahoma.

Horticultural Operations

The total irrigated horticultural area in the open was about 15,000 acres in 2018, decreased significantly compared to about 22,000 in 2013 and 20,000 in 2008. About 94% of the area in 2018 was dedicated to sod production in the open. Nursery crops were next in the row, with about 5% of the total irrigated area. Ninety-six percent of all irrigated horticultural area in the open was under sprinkler irrigation systems and the remaining 4% was under drip, trickle or low-flow micro irrigation. Like agricultural irrigation, groundwater from wells was the main source of water for horticultural irrigation, accounting for 72% of all water used for irrigation in the open. Seventeen percent was supplied from on-farm surface water resources and the remaining 11% came from off-farm suppliers.



EXTENSION

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 and semi-arid western parts of the state. In recent years, irrigated agriculture has been challenged by prolonged droughts and strong competition from industrial, urban and environmental sectors over limited freshwater resources. These constraints along with the increasing demand in food, feed, fiber and fuel necessitate the urgent need to provide Oklahoma producers with tools to improve irrigation management and maximize water productivity. This task, however, is not possible without understanding the current situation of irrigated agriculture and investigating its potential weaknesses and opportunities.

This fact sheet provides an overall picture of the state of irrigated agriculture in Oklahoma. The information and analysis are based on the data published in the Irrigation and Water Management Survey (previously known as the Farm and Ranch Irrigation Survey) conducted in 2018 by the National Agricultural Statistics Service of the USDA.

Irrigation and Water Management Survey, 2018

The 2018 Irrigation and Water Management Survey adds detailed irrigation-related information to the basic data collected from all agricultural operations in the 2017 Census of Agriculture. Some of the 2018 data are not comparable with previous survey reports conducted in 1997, 2003, 2008 and 2013, since the definition and reporting of some operations (e.g. horticulture in the open) has changed. Comparisons in this fact sheet are made keeping this point in mind to avoid misleading conclusions.

General Information

According to the 2018 survey, Oklahoma has 1,835 farms containing irrigated lands. The total area of land in these farms exceeds 3.4 million acres, with an actual irrigated area of 601,492 acres. This shows a 41% increase compared to the total irrigated acres in 2013 survey and a 30% increase compared to the 2008 survey. The larger increase compared to 2013 is probably due to the severe drought of 2011-2014, which resulted in many farms losing their ability to irrigate in those years. In terms of actual irrigated acres, Oklahoma is ranked 22nd among all 50 states. All our neighboring states have significantly larger

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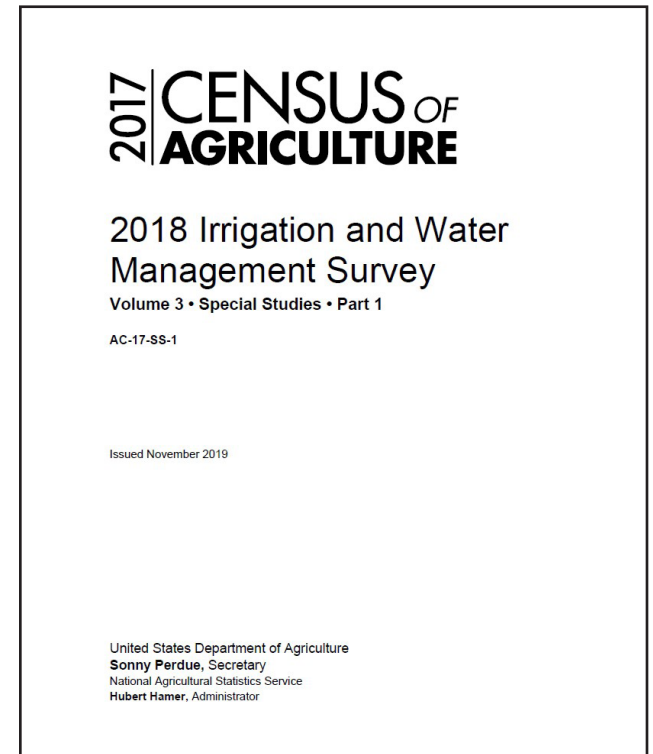


Figure 1. The 2018 survey cover page.

irrigated areas, ranging from New Mexico with about 675,300 acres (ranked 21st) to Arkansas with 4.25 million acres (ranked 3rd).

The total amount of irrigation water applied in the survey year was 662,063 acre-feet, which is equal to more than 215 billion gallons. This shows a 27 and 26% increase compared to 2013 and 2008 estimates, respectively. The increase in the total amount of applied water seems to be caused by the expansion of irrigated area and not necessarily a change in the amount of irrigation applied to a unit of land. Less than 0.1% of the total amount was applied to operations under protection (e.g. greenhouse) and the remaining (99.9%) was applied to operations in the open.

Eighty-five percent of the total water applied in the open in 2018 was supplied from groundwater resources and the remaining 15% from surface resources. This indicates a smaller

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Figure 2. An irrigation canal taking water from Lake Altus in southwest Oklahoma to agricultural fields.

reliance on groundwater compared to 2013, when groundwater accounted for 92% of irrigation water applied in the open. The larger dependence on groundwater in 2013 was probably a result of the 2011-2014 drought, which severely limited surface water resources. The share of groundwater in supplying irrigation was about 83% in 2008, like 2018. However, the volume of groundwater withdrawn for irrigation in 2018 was 30% larger than 2008 and 17% larger than 2013. This increase in the total amount of groundwater extraction could shorten the life of those aquifers that have a limited recharge capacity, such as the Ogallala aquifer in Oklahoma Panhandle. It should be noted that the reported amount of applied water is based on irrigators' best estimate and not metered flow rates.

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 2018, only two farms in Oklahoma reported the use of reclaimed water for irrigation. This number was 40 farms with total irrigated acres of 3,775 and 18 farms with total irrigated acres 2,205 in 2008 and 2013, respectively. These statistics suggest there is a significant potential for reuse of reclaimed water in irrigated agriculture in Oklahoma.

Irrigation Wells

According to the survey, 5,702 irrigation wells were in use on Oklahoma irrigated lands in 2018, which is 16% more than 2013 and 53% more than 2008. Among all wells surveyed in 2018, 19% had meters to monitor groundwater withdrawal, up from 16 and 13% in 2013 and 2008, respectively. In addition, 35% of wells did not have a backflow prevention device (up from 29% in 2013), 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 2018 average well depth was 194 feet in Oklahoma, smaller than the average depth in 2013 (219 feet) and 2008 (237 feet). The average depth to water estimated at the beginning of the growing season was 87 feet in Oklahoma, according to the 2018 survey. Compared to 2013 survey, only 9% of Oklahoma wells showed an increase in depth to water, while 45% reported no change. However, the 2018 average pumping capacity was 368 gallons per minute (gpm), which was 10% less than 2013 and 27% smaller than 2008. The decline in pumping capac-

ity over time is consistent with increase in total groundwater withdrawal mentioned before. The national average pumping capacity in 2018 was 708 gpm.

Irrigation Pumps and Energy Costs

Regardless of water source (surface or ground), many 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 2018 Oklahoma producers spent about \$21.5 million in energy expenses to power 6,530 pumps. Though producers powered more pumps in 2018 compared to 2013 and 2008, they expended 3% less compared to 2013 and 31% less than 2008. Taking irrigated acres into account, the amount of energy expenditure in 2018 translates into \$42 and \$18 per acre for groundwater and surface water irrigation, respectively. Electricity was the main source of pumping energy, supplying water to 46% of all irrigated acres in state. The second major energy source was natural gas, which contributed 39% in 2018. The third most-used energy source was diesel, which powered pumps to irrigate 15% of the remaining irrigated acres in 2018.



Figure 3. A natural gas engine extracts groundwater for irrigation.

Other Irrigation-Related Expenditures

In addition to the energy expenses mentioned above, Oklahoma producers spent another \$38.2 million on irrigation equipment, facilities, land improvement and computer technology. This was about two times more than 2013 in terms of the total amount, but slightly smaller when translated to average expenditure per affected acre (\$107 in 2018 versus \$118 in 2013). A large portion of this money (64%) was spent for scheduled replacement and maintenance. About one-third (34%) of the total expenditures was dedicated to new expansion. Only 2% was used for water conservation, significantly smaller than the corresponding percentages in 2013 (18%) and 2008 (20%) and the 2018 national average (18%). Only 3% of irrigated acres where mentioned expenditures were made received financial assistance from EQIP or other USDA programs.

Oklahoma producers paid above \$7.8 million of total labor expenses in 2018, which was around 1.7 times larger than 2013 and four times larger than 2008. Out of this amount, about \$5.5 million was spent on hired labors and over \$2.3 million on contract labor. Furthermore, the average hired labor expenses per farm was \$19,188, whereas contract labor per farm expenses was \$15,022.

Irrigation Interruption

Out of all irrigated acres in Oklahoma, only 2% experienced an irrigation interruption in 2018 that resulted in diminished crop yield. One of the leading causes for irrigation interruption was equipment failure, affecting 45% of all acres that reported interruption. Groundwater shortage was another reason for irrigation interruption, reported by 12% of total interrupted acres. According to the 2013 survey, which was conducted during drought, groundwater shortage was responsible for irrigation interruption at 32% of irrigated acres.

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 2018, mentioned by 84% of irrigated farms. The next most common method was the "feel of soil," used by 36% of all irrigators. The third most common method was based on "personal calendar," implemented in 10% of all farms. Smart methods such as soil moisture sensing devices, plant sensing devices and computer models had a low adoption rate, with each one of them being mentioned by less than 5% of irrigated farms. Among these smart methods, the use of soil moisture sensing devices in Oklahoma lags the national average and many neighboring states. The percentage of farms that used these sensors was 12% across the nation, 10% in Texas, 11% in Arkansas, and 19% in Kansas. Nebraska was the leading state, with about one-third of all irrigated farms having adopted the soil moisture sensing devices in their irrigation scheduling. Surprisingly, the use of soil moisture sensors in Oklahoma was two times larger back in 2013 at 11%, similar to the national average. It is not clear why the adoption rate has declined dramatically in the 2018 survey.



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

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 3% of Oklahoma farmers. This is less than the U.S. average (7%) and several other states such as Kansas (17%) and Nebraska (21%). This information suggests that 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%, since many irrigators use more than one method to decide about irrigation timing.

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. According to the 2018 survey, a major barrier was related to financial challenges. Thirty-five percent of farmers said that they could not finance improvements, up from 26% mentioning this barrier in both 2013 and 2008 surveys. Twenty-five percent of producers mentioned that improvements would not reduce costs enough to cover installation costs and 26% noted that landlord would not share in costs. Only 16% of producers mentioned that water and energy conservation was simply not their priority, which shows a decline when compared to 19% in 2013 and 29% in 2008.

Sources of Irrigation Information

The most relied upon source of irrigation information in the state was university Extension specialists and educators, mentioned by about half of all irrigated farms in 2018 (46%). This was similar to 2013, but different than 2008 when irrigation equipment dealers were the major sources of irrigation information. Irrigation equipment dealers and neighboring farmers were the next two sources of information in 2018, each mentioned by about one-third of irrigated farms. Private irrigation specialists and consultants served as the source of information for 27% of respondents.

Irrigation Systems

Irrigation systems can be generally divided into three main categories of gravity (a.k.a. surface or flood), sprinkler



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