# OKLAHOMA

## AGRICULTURAL EXPERIMENT STATION

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# IRRIGATION FOR OKLAHOMA.

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Director and Agriculturist.

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# OKLAHOMA

# AGRICULTURAL AND MECHANICAL COLLEGE.

# AGRICULTURAL EXPERIMENT STATION.

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# IRRIGATION IN OKLAHOMA.

By G. E. MORROW, Director and Agriculturist.

The possibility of successful irrigation, or the watering of the soil by artificial means as an aid to crop production, is attracting much attention in Oklahoma. It is the desire of those in charge of the Oklahoma Agricultural Experiment Station to give all possible aid to the settlement of this question. So far as means permit experiments will be tried in irrigation by different methods at the Station and investigations will be made in different parts of the territory. The authorities at Washington have decided that the Station cannot provide irrigation plants, whether ponds, wells, windmills or other pumping apparatus, except from a fund of $750 per annum, out of which all buildings, or other permanent improvements, or the repairs of such of any kind for any Station use must be provided for—unless funds are supplied by the territory.

As a contribution to general information on the subject, the report made to Governor Renfrow by delegates appointed by him to represent the territory at the Fourth National Irrigation Congress at Albuquerque, New Mexico, September, 1895, is published, with some statements designed to guard against possible mistakes by those engaging in attempts to irrigate their lands.

## RAINFALL IN OKLAHOMA.

The annual rainfall in Oklahoma differs much in different portions of the territory, and, of course, varies greatly from year to year. Observations have not been taken long enough at any considerable number of places in the territory to clearly indicate local influences. There is good reason to believe that, as has been the case over much of the United States, the rainfall for the last two or three years has been below the average. There is no good reason for believing that the average annual rainfall in any part of the territory will materially differ from that in Kansas and Texas due north and south. It is admitted that, for the territory as a whole, the rainfall is not as great as that in much of the country lying farther east. Much of Oklahoma lies in what is called the semi-arid region of the United States. The heaviest annual precipitation, in a series of years, is in the southeastern part of the territory. In general the amount decreases from the east to the west. Exact lines of division cannot be drawn, but it is safe to say that the eastern part of the territory, say that part lying east of the 97th meridian, has an average rainfall of over 30 inches; while the part lying farther west has between 20 and 30 inches, except in the extreme west.

(The frequency with which such statements are misunderstood, justifies an attempt to guard against such mistakes, by saying that it is not meant that there is any line on one side of which the rainfall is perceptibly greater than on the other, and that it may happen that the rainfall will be much greater in the western than in the eastern part in a given month or for a year.)

At different army posts in the Indian territory and what is now Oklahoma, meteorological observations have been kept for a considerable number of years. Since the opening of Oklahoma to settlement observations have been made at a few places—at a considerable number since the establishment of a Climate and Crop Station at Oklahoma City in 1891. Unfortunately the records from most of these points have imperfections. Through the courtesy of the chief of the Weather Bureau at Washington and of J. I. Widmeyer, observer at Oklahoma City, much valuable data has been placed at the disposal of the writer.

At Fort Towson, in the southeastern part of the Indian territory, the average rainfall for a series of years between 1837 and 1853, was 51.53 inches. At Fort Gibson, Lat. 35° 50′; Long. 95° 20′, records were kept, with the exception of three years, from 1837 to 1889. The average rainfall was 35.74 inches. There were great variations. In 1840 over 55 inches fell, while in 1838 there were less than 19 inches. At Tulsa, Indian territory, about Lat. 36° 10′, Long. 96° the average rainfall for six years, from 1889 to 1895, was 34.20 inches. Each of these points is east of the present boundary of Oklahoma.

At Fort Sill records have been kept since 1870, with exception of two years. This is Lat. 34° 40′; Long. 98° 25′. The average rainfall for twenty-four years was 30.36 inches; the heaviest, 48.45 inches, in 1877; the lightest, 19.57 inches, in 1886. At Fort Reno, Lat. 35° 35′, Long. 98° the average for the last seven years has been 27.2 inches; the greatest, 33.51 inches, in 1892; the lightest, 17.28 inches, in 1894. From Fort Supply, about Lat. 36° 34'; Long. 99° 34', we have records for the six years, 1889 to 1894, except the last month. The average rainfall was 24.28 inches.

Some facts as to rainfall at different places are given in tabular form, with more detailed information concerning rainfall at Oklahoma City and Fort Supply. These tables will well repay careful study. The rainfall for any one or two years may differ much from the normal or usual rainfall.

A satisfactory distribution of the rainfall is almost as important for successful crop production as is a sufficient annual supply. In this respect Oklahoma is fairly but not entirely fortunate. We have no distinct wet and dry seasons. Generally the principal rainfall occurs during the growing season. On the other hand, drouths during critical periods of crop growth are not uncommon. The total rainfall is sometimes largely made up of excessively violent rains and of very slight showers. Most of the water from the former is lost; that from the latter cannot penetrate the soil to any perceptible depth. In general the rainfall is light during the first three months of the year, and comparatively so during November and December. A precipitation of from nine to twelve inches in a single summer month is not uncommon. The records for a series of years at six different places show an average rainfall for the four months of November, December, January and February of 6.73 inches; adding March and the average is 8.80 inches. For four months, April, May, June, July, the average rainfall was 13.72 inches; adding August and the average is 16.67 inches.

Another unfavorable fact is that evaporation of moisture from the soil is very great in Oklahoma. The great number of bright, sunshiny days, with high temperature and with strong, warm, dry winds during all the crop growing season furnishes the best possible conditions for such evaporation. The mean annual temperature, as well as the mean for each month, is satisfactory, but the extremes of temperature are great. In both 1894 and 1895 temperatures below zero and above 100 degrees were reported from almost every point sending reports. With a high temperature, and a strong wind, containing little moisture, the evaporation from the soil is very rapid. The mean monthly temperature at Oklahoma City for a series of years is given in the table.

*Monthly Mean Temperature, Oklahoma City, O. T.*

| YEAR. | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 1891 | 37.8 | 39.2 | 43.6 | 60.8 | 64.4 | 74.3 | 76.2 | 76.8 | 72.4 | 60.8 | 47.0 | 44.4 | 58.1 |
| Year 1892 | 33.0 | 44.5 | 44.6 | 59.2 | 66.2 | 75.1 | 79.0 | 77.0 | 72.4 | 62.0 | 48.0 | 35.6 | 58.0 |
| Year 1893 | 37.6 | 35.8 | 50.2 | 62.4 | 65.4 | 76.2 | 81.2 | 75.2 | 74.4 | 61.7 | 45.4 | 43.7 | 59.1 |
| Year 1894 | 36.8 | 34.8 | 52.6 | 62.9 | 68.2 | 75.4 | 79.4 | 78.4 | 74.4 | 64.0 | 49.8 | 41.6 | 59.9 |
| Year 1895 | 33.2 | 29.5 | 50.0 | 63.1 | 69.3 | 76.8 | 78.3 | 79.1 | 76.1 | 55.7 | 45.0 | 38.4 | 57.9 |
| Averages | 35.7 | 36.7 | 48.2 | 61.7 | 66.7 | 75.5 | 78.8 | 77.3 | 73.9 | 60.8 | 47.0 | 40.7 | 58.6 |

*Precipitation—Oklahoma City, O. T.*

| YEAR. | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 1891 | 2.48 | .44 | 3 04 | 4.30 | 5.92 | 4.73 | 6.17 | .79 | 5.43 | .31 | 1.17 | 2.65 | 37.43 |
| Year 1892 | .93 | 2.22 | 3.17 | 1.33 | 11.90 | 2.48 | 3.66 | 4.27 | 1.29 | 4.68 | 1.01 | 5.35 | 42.29 |
| Year 1893 | .43 | .69 | 1.25 | 3.12 | 1.53 | 1.60 | 3.80 | 5.65 | 3.20 | .06 | 1.26 | 1.69 | 24.28 |
| Year 1894 | 3.74 | 1.11 | 4.79 | 2.82 | 1.87 | 3.71 | 1.66 | 1.95 | 1.65 | 1.84 | .07 | 1.51 | 26.72 |
| Year 1895 | .93 | .07 | .82 | .41 | 1.34 | 3.11 | 5.95 | 4.44 | 2.93 | 2.93 | 5.79 | 3.78 | 32.49 |
| Average | 1.70 | .90 | 2.61 | 2.39 | 4.51 | 3.12 | 4.25 | 3.42 | 2.90 | 1.96 | 1.86 | 2.99 | 32.64 |

*Precipitation—Fort Supply, O. T.*

| YEAR. | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 1889 | .90 | .10 | 2.11 | 1.33 | 2.29 | 2.90 | 2.17 | 3.45 | 2.02 | 4.99 | 1.35 | 0 | 23.61 |
| Year 1890 | 1.80 | .18 | 0 | 2.98 | 2.21 | 2.37 | 1.74 | 3.33 | 1.29 | .74 | 1.53 | .09 | 18.26 |
| Year 1891 | 2.67 | .60 | 2.89 | .28 | 3.75 | 4.85 | 8.12 | .90 | 1.52 | 2.33 | 1.21 | 1.31 | 30.43 |
| Year 1892 | 0 | 2.02 | 3.02 | .55 | 4.48 | .65 | 1.55 | 4.52 | 1.15 | 1.85 | .40 | 1.80 | 21.99 |
| Year 1893 | .02 | .62 | .20 | .25 | 1.43 | .74 | 1.60 | 4.37 | 2.72 | 0 | .70 | .50 | 13.15 |
| Year 1894* | .25 | 1.04 | .12 | 4.36 | 5.22 | 1.31 | 2.63 | .26 | 2.29 | .49 | .25 | ........ | 18.24 |
| Mean | .94 | .76 | 1.39 | 1.62 | 3.23 | 2.13 | 2.97 | 2.80 | 1.83 | 1.73 | .91 | .74 | 24.28 |

*Rainfall in Inches and Hundredths, in Oklahoma Territory.*

| PLACE. | COUNTY. | 1889 | 1890 | 1891 | 1892 | 1893 | 1894 | 1895 |
|---|---|---|---|---|---|---|---|---|
| Burnet | Pottawatomie | ........ | ........ | ........ | 41.84 | 26.65 | 25.40 | 36.17 |
| Fort Reno | Canadian | 31.91 | 28.79 | 26.77 | 33.51 | 29.40 | 17.88 | 22.78 |
| Fort Sill | Comanche, I. T. | 29.29 | 31.08 | 32.76 | 34.32 | 24.19 | 24.14 | 29.17 |
| Fort Supply | Woodward | 23.61 | 18.26 | 30.43 | 21.99 | 13.15 | *18.24 | ........ |
| Guthrie | Logan | ........ | ........ | ........ | 37.98 | ........ | 22.99 | 30.71 |
| Mangum | Greer | ........ | ........ | ........ | *27.10 | 11.17 | 19.52 | ........ |
| Oklahoma City | Oklahoma | ........ | ........ | 37.43 | 42.29 | 24.28 | 26.72 | 32.49 |
| Pond Creek | Grant | ........ | ........ | ........ | ........ | ........ | 17.69 | 21.56 |
| Purcell | Chickasaw, I. T. | ........ | ........ | ........ | 40.03 | 32.38 | 24.88 | ........ |
| Tulsa | Creek, I. T. | 26.28 | 34.15 | 24.80 | 46.16 | 34.12 | 27.09 | 46.81 |
| Winview | | ........ | ........ | 19.34 | ........ | ........ | 29.98 | 26.19 |

*For eleven months.

There is reason to believe the rainfall in the Indian Territory and Oklahoma is somewhat greater than that in the same longitude in Kansas. Recent reports give the average rainfall in some of the eastern counties of Kansas at 40 inches; of some in the extreme western part of the state as 15 inches. Dividing the state into three fairly equal parts, the averages are over 33 inches for the eastern, 24 inches for the central and 18 inches for the western part.

Different crops vary considerably in the quantity of water required to bring them to maturity, but in all cases the quantity is very large. Careful experiments have shown that different grain crops have taken up from the soil from 300 to nearly 600 pounds of water for each pound of dry matter in the plant. To this is to be added the enormously large quantity of water evaporated from the soil direct, even when it is fairly covered with vegetation. It has often been stated that an annual supply of from 20 to 24 inches of water, if this could be secured as most needed, would be sufficient for successful growth of most ordinary farm crops. In irrigation it is not necessary to supply any such quantity as this, except in rainless regions. What is necessary is to supply the deficiency in the natural supply, or to save a part of the water which falls in excess at some times and apply it when it is most needed. It is probable that fair or good crops could be secured in most parts of Oklahoma, even in seasons of severe drouth, if it were possible to apply from four to eight inches of water to the soil at such times as it is most needed.

The soil of the greater part of Oklahoma is fertile; much of it is very fertile. Given a sufficient and well distributed supply of water and fair or good crops are reasonably certain. Nature does not always give us a sufficient supply; the rainfall frequently comes with such violence that much of the water runs away, especially that which falls on the rolling prairies. In many places the soil, especially at a little distance below the surface, is so compact the water cannot readily enter it. High temperature and dry winds carry away much moisture when it is most needed. What can farmers as individuals or collectively do to secure better conditions in unfavorable seasons? In many cases a good deal can be done to help the soil store up and hold the rainfall.

## SUBSOILING AND SURFACE CULTURE AS HELPS TO MOISTURE SAVING.

Most soils have a remarkable power of absorbing and holding water. As water penetrates a dry soil, each particle of the soil holds a thin film of water about it and seems reluctant to let it go. Even in what seems to the eye to be dry soil, there is often eight or ten per cent. of water. Much of the soil of Oklahoma will hold from one-fourth to one-third of its bulk of water. That is, if these soils were thoroughly dry and a gentle rain should fall on a level surface, the soil to a depth of one foot would hold a rainfall of three to four inches in depth. If there is a hardpan subsoil, impervious to water, a sufficient rainfall would fill all the space between the soil particles. In such case a soil with coarse particles would hold more water than one more finely divided, but the latter would hold more by the power of attraction than would the coarse textured soil—except where the soil particles were so excessively fine that the water could not penetrate the soil.

It happens unfortunately that a good deal of the soil in Oklahoma, notably the red-colored prairie soil, while having large power of holding moisture, is so finely divided that water penetrates it slowly. Especially on side hills much of the water even in gentle rains passes off over the surface. Two modes of making this soil more open can be made use of. Adding decayed vegetable matter to such soil will be a great help. Saving and applying stable manure is to be advised for such soils, not only because this adds plant food but because it helps the soil to readily take in and better hold water. The growth of deep-rooted plants, like alfalfa, has much the same effect. Except for the purpose of destroying insects, the practice of burning stubble or cornstalks is not to be advised.

Subsoiling is also a great help in making the soil a better storage place for the water which falls in rains. It needs no argument to prove that a soil that has been made fairly loose to a depth of fifteen or twenty inches will take and hold more of the water which falls in a hard rain storm than will one which has a compact subsoil at a depth of eight or ten inches. In regions which have porous subsoils, subsoiling, or even deep plowing, often is not profitable. The evidence is conclusive that subsoiling has been profitable in a good many cases in Oklahoma and a larger number in Kansas and Nebraska.

In most cases subsoiling in the fall is much better than spring subsoiling. If a dry season follows the latter, the effects may be bad. Deep stirring in the fall fits the ground to receive the rains of fall, winter and early spring.

In like manner the application of a large quantity of unrotted manure may greatly lessen the crop in a dry year; while applying well rotted vegetable matter will almost always be helpful.

A chief source of loss of moisture from the soil is evaporation into the air. Frequent, shallow cultivation during the growing season is an effective means of reducing this evaporation. The good results from applying a mulch to the surface about newly planted trees is well known. Dry earth is an excellent mulch. It is not practicable to draw dry earth with which to cover our fields, but it is possible, in case of crops which we cultivate, to secure much the same result by pulverizing the surface, thus leaving a "dust mulch." It is not necessary to stir the soil to any considerable depth. Some loss of moisture is caused by the stirring. The prevalence of strong winds makes this method of preventing or reducing evaporation less practicable here than in some regions. Obviously, another method of preventing the waste of moisture from the soil is to keep weeds from growing. These need moisture as well as do the useful plants. In many cases weeds do more harm by taking moisture from the crop than they do by taking plant food.

### THE WATER SUPPLY FOR IRRIGATION.

If irrigation is to be practiced on the majority of the farms in Oklahoma, it must be by the use of water drawn from wells, or from ponds in which storm water has been stored. The rivers and streams of the territory do not have wide valleys as a rule. It is not probable that much will be done, for some years at least, in the way of organizing companies for building canals and establishing large irrigation systems. As yet little is known as to the existence of "underflow waters," even in the river valleys. Nothing is known, with certainty, as to the possibility of securing large supplies of water from artesian wells in this region. The water of some of the rivers and smaller streams has so much saline matter that its use for irrigation would be objectionable.

The most practicable power for lifting the water, in a vast majority of cases, is a windwheel.

A first question, then, before preparing to irrigate land, is to determine whether a sufficient water supply can be secured. There is danger of serious mistake being made as to this. Harm has been done by advocates of irrigation whose enthusiasm was more pronounced than their care to be accurate. It is a well known fact that harm rather than good is often done growing plants by sprinkling the surface with water during dry weather. So slight applications of water by irrigation may do no good—even harm. The water must be ready for use when needed. It will not do to calculate the capacity of the well or pump for a year and rest with this, as in many cases the water used must be pumped almost as needed; or very large reservoirs be constructed. It is possible to lift water from a deep well, but the power required is vastly greater than that necessary for lifting the same quantity from a shallow well.

A barrel of water, of 31.5 gallons, applied to a plat of land five by ten feet would equal a rainfall of one inch. Or it would take about 860 barrels of water, per acre, to equal a rainfall of one inch. This will weigh well over 100 tons. If one must depend on a well, it must be seen to that it is capable of supplying the necessary quantity of water and that the windmill has power enough to raise it in reasonable time.

Fortunately, very many Oklahoma farms are admirably suited for the collection of storm waters, from a considerable acreage, into ponds, from which the water may be lifted by pumping, either for direct application or to be stored in smaller reservoirs on higher land, from which it can be conducted into the irrigating furrows. There is, necessarily, much loss by evaporation from these ponds. Securing the greatest depth reasonably attainable is the only practicable means of lessening this loss. In many cases the quantity of land which can be irrigated from a pond of a given size has been greatly overestimated, as has the quantity of storm water which can safely be counted on from a given acreage. To furnish water sufficient to irrigate ten acres with four inches of water, a pond 100 feet square would have to be filled to a depth of about 14 feet, and this without counting the large loss from evaporation. Great care is also necessary in making the ponds, else there may be large loss from seepage.

The writer strongly advocates the building of ponds for storing water on Oklahoma farms. He is not able to agree with those who believe this would greatly increase the rainfall, although he believes it might have an appreciable effect in this direction. In many cases this pond water may be wisely used in irrigation work. In many more cases such water may be the most convenient supply for farm stock and a safeguard against trouble and loss in times of drouth.

Successful irrigation is an art to be learned by experience, observation, trial, even when the water supply is abundant. This is an additional reason for heartily commending the advice given in the report of the delegates to the Irrigation Congress, published as a part of this bulletin, that the first efforts be made on a small scale. In many cases, however, it will be wise to procure a larger windmill than is needed, or thought to be needed, for the experimental work; thus saving the necessity of purchasing a larger one, when it is proposed to extend the irrigation work.

## SUB-IRRIGATION.

While irrigation by applying water to the surface, either by flooding or by means of furrows, is the most common method, there are some decided advantages in what is called sub-irrigation; that is, applying the water below the surface, through drain tile or other pipes. By this method the water is applied more nearly where it is needed, the loss by evaporation is lessened, and there is no tendency to the formation of a hard crust on the surface.

The increased cost of this method will prevent its general adoption, but it may be advisable where small plats only are to be irrigated. This plan has been followed with most satisfactory results in the culture of vegetables under glass.

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Some possible dangers and mistakes have been pointed out, not to discourage trials of irrigation, but to prevent losses from unwise attempts. The writer would strongly encourage farmers in the valleys of rivers or streams of Oklahoma, water from which can be diverted or dammed without too great cost, or who know they can get a large supply from wells, or who can collect pond water in sufficient quantity, to make a trial of irrigation, commencing with a garden or small orchard. He as strongly urges all farmers to do what they can to help the soil take and hold the largest quantity of the rains sent by nature, and to so cultivate that as little as possible of this may be wasted.

# REPORT OF OKLAHOMA DELEGATES

TO THE

## Fourth National Irrigation Congress, Held at Albuquerque, New Mexico, September 16-20, 1895.

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[Governor W. C. Renfrow appointed Hon. J. V. Admire. Hon. R. L. Delaney, and Professor A. C. Magruder delegates to represent the Territory of Oklahoma at the Fourth National Irrigation Congress, held at Albuquerque, New Mexico, September 16-20, 1895. Upon their return from the Congress, these delegates submitted the following report to the Governor:]

The delegates appointed to attend the sessions of the Fourth National Irrigation Congress entered upon their work with comparatively little comprehension of the vast importance of the work in hand and the value that such work might be to our territory. But we soon became impressed with its importance and its necessity, and took advantage of every opportunity to learn all that could be learned, that we might in this report give at least information enough on the subject to cause our farmers and gardeners to want more. If but a few are impressed with the value of irrigation to our country and will adopt our most important of all suggestions; that is, to try at first but a quarter of an acre—not in any case more than half an acre, we will feel that our time and money were well spent, nothwithstanding the fact that all our expenses came out of our private purses. not a dollar of the expense being defrayed by the territory.

Our attendance upon the sessions of the congress was constant, and the many valuable papers on matters pertaining to irrigation we listened to with a view to getting out of them all we could. Of course a reproduction of those papers in this report would be out of place.

### NEED OF IRRIGATION IN OKLAHOMA.

The first question that naturally arises is: "Is there any need for irrigation in Oklahoma?" In answer to this question we would say the rainfall for the territory is generally sufficient to mature all our crops were it properly distributed. But this is not the case, and any system that will aid in properly distributing this water will be of great advantage. The average yearly rainfall for the territory is about 27 inches. This is five inches in excess of what is actually necessary, yet we must take into consideration the fact that much of the 27 inches of rain falls in such small showers that no good results are obtained. Yet these small showers of .01 or 1 inch, in themselves of no great value, go to make up our total rainfall.

### WATER SUPPLY.

There are three sources of water for irrigating purposes in Oklahoma: First, and for the greater part of the territory the most important, is the storing of the storm waters in pools, ponds, artificial lakes or reservoirs. The second is pumping from the underflow. The third is the diversion of water from our rivers and creeks to large reservoirs, where it is stored until needed.

The impounding of storm waters has been given the first place for the reason that on nearly every farm in Oklahoma a dam may be constructed by which a pond may be formed which will furnish sufficient water to irrigate certainly as much as one acre.

It has been suggested by some of the best legal ability of the territory that a law should be enacted by the next legislature, providing for the remission of a certain part of the taxes on his land to every person who maintains on his farm a pond or ponds covering say two and one-half acres, with an average depth of three or four feet. If such ponds could be built on each quarter section of land in Oklahoma, we would have ten acres covered with water on each square mile—in the aggregate a large area. Such conditions would perceptibly modify the climatic conditions of Oklahoma, and militate in a great degree against the ruinous effects of the hot winds of late June and early July. That such ponds can be constructed is shown by the large number already dotted over the territory.

By the underflow is meant that water from 10 to 20 feet below the surface which actually flows through the soil at a more or less rapid rate, depending on the mechanical condition of the strata through which it passes. In coarse sand it flows much faster than in fine sand. On the rapidity of the flow depends largely the supply of water. There exists, in reality, three underflows: First, a perceptible current extending, according to Professor Haworth of the University of Kansas, from the

Gulf of Mexico through Texas, western Oklahoma, western Kansas, and into Nebraska. Second, each water course has an underflow which corresponds in width to the valley through which it flows. The supply from this underflow is as constant and as great as, or greater, than that in the rivers themselves. The third underflow is known as the upland underflow, lying from 20 to 200 feet below the surface. The eastern boundary of the underflow in Kansas is marked by a zigzag line, crossing and recrossing the 100th meridian many times. No investigations have been made in Oklahoma on this subject. There may also be in Oklahoma, as in Kansas, independent underflows in different counties.

The underflow water is reached by sinking wells, and is elevated to the surface by windwills, steam or gasoline engines, or by horse power. Some statistics furnished us by the secretary of the Kansas Irrigation Commission, will prove interesting in this connection. The average cost of different kinds of power for elevating water for irrigation, as compiled by that commission, is as follows: Horsepower, $73.75; windmills, $118.31; steam engines, $283.12; gasoline engines, $486.00. From these figures we may justly decide in favor of the windmill as the proper power, although it is more expensive in first cost than the horsepower, but it requires no attention after once in operation. Out of 545 answers to questions sent out by the Kansas Commission as to the power used in pumping, 5 named gasoline engines, 12 steam engines, 16 horsepowers, and 512 windmills.

As to the third source of supply, that of streams, called run-off water, we have, flowing through Oklahoma from northwest to southeast, the Cimarron, the North Canadian, the South Canadian, the Arkansas, the Red, the Cottonwood, the Salt Fork and the Washita, besides innumerable small creeks, which have bottom lands lying on either side, varying in width from a few rods to more than a mile. It is often the case that we stand idly by in certain seasons of the year and see these water courses overflowing and running wild with a wealth of water which leaves us forever. We believe these waters may be held by diverting them into large catchment areas to be let out later when the land has become dry and is thirsting for water.

This work of irrigation is no longer a local question. It is of state and national interest, and deserves attention at the hands of our representatives in our legislature and in congress. How great the advantage would be to us if the United States

Geological Survey would establish measurement stations on our water courses, that we might know how much water may be depended upon; if they would make surveys of our territory and locate the catchment areas for storing all the waters now leaving us, holding them where they may do good instead of allowing them to work ruin along the lower Mississippi in the annual overflows of that river!

That some idea may be gained of the rapidity with which this work of irrigation is being taken up, we give a few figures collected by the Irrigation Commission of Kansas, showing the number of irrigation plants started in that state in each year from 1888 to 1895, inclusive: 26, 13, 28, 18, 33, 55, 224, 1241. Out of 816 persons who answered as to the source of the water supply, 220 used water from streams, 590 that from wells and six collected storm waters in reservoirs. In answer to the question, "is irrigation a success?" 338 answered "yes," and six "no." These figures relate to the work of those who began irrigation before 1895. As bearing on the important question how high may water be lifted for irrigation purposes we give the depth of some wells used by successful irrigators in Kansas. There were 16 wells 10 feet deep; 96, 20 feet deep; 54, 30 feet deep; 63, 40 feet deep; 22, 50 feet deep; 23, 60 feet deep; 14, 70 feet deep; 34, 80 feet deep; 21, 90 feet deep; 31, 100 feet deep; 12, 110 feet deep; 14, 120 feet deep; 21, 130 feet deep; 8, 140 feet deep; 16, 150 feet deep; 12, 160 feet deep; 5, 170 feet deep; 12, 180 feet deep; 5, 190 feet deep; 4, 200 feet deep; 1, 220 feet deep and 2, 240 feet deep.

## HOW TO IRRIGATE.

The general criticism offered by those who are more or less interested in irrigation is that they can get hold of no information telling them how to proceed with the work. This is a hard question to answer on paper, without the use of diagrams and pictures to show pools, pumps, main drains and laterals, but we will attempt it.

The first step is to locate your water supply. If you are on a stream, perhaps your best plan is to throw a dam across the stream, and conduct the water through a side ditch to a reservoir lower down which will command the lands to be irrigated. Or, you may pump from stream to reservoir constructed on higher land. If you are not located on a stream you may be able to make arrangements to conduct the water in ditches from the stream to your land. If this is impracticable, then your next best plan, perhaps, will be the impounding of the storm waters in pools made by throwing dams across draws. As a last chance you have the underflow from which sufficient water may be gained to supplement the rainfall, so fully as to insure you full crops—not on your entire quarter section—not on ten acres—not on five acres, but may be, on one. You could count with most certainty on being successful, if you attempted to irrigate but one-half or one-fourth an acre at first. A reservoir 100 by 100 feet, built on top of the ground, or not more than 12 inches below the surface, with banks three feet high, will hold 40,000 cubic feet of water. By this is meant enough water to cover 40,000 square feet 12 inches deep. The term, acre foot means the amount of water that will cover one acre of land one foot deep.

Irrigation is not a sure thing. You are as apt to ruin crops by too much water as by too little. Do not think for a moment that water turned on a crop means a full crop, with no further attention. On the other hand irrigated soils require the best cultivation, care and management, if they are to repay you for this extra trouble. If you are sure that you have the water to turn on the potatoes when they are just "setting;" to turn on the strawberry bed when the dry spell commences, it is not like waiting for rain. To the average farmer, the cultivation of a single acre, or a fraction of an acre, seems trifling; yet many do not hesitate to put in an acre or more of potatoes and have nothing to blame but the weather when 25 or 50 bushels constitute the full yield. They would, indeed, be surprised if they got 50 bushels from the one-fourth or the one-sixth of an acre irrigated, and this they may do under ordinary circumstances.

It has been demonstrated that one acre properly irrigated and cared for is sufficient to keep a family of six in provisions. It may be said this is not much after all. We answer: Let every farmer in Oklahoma for one year raise on his own farm all he consumes at home, and we will at the end of that time see a different Oklahoma than we have today. To raise at home all that is consumed there is the basis of success, and until this is done our country is not healthy and will not grow.

Under the term, "Individual Irrigation," is placed all plants owned and operated by farmers, individually. Each has his own mill and water supply, reservoirs, etc., and is in no way dependent upon any other person. This differs materially from the

"Co-operative System," where many farmers construct a joint canal, leading from a large water supply. Each system has its merits and disadvantages. More water is likely to be gotten in the co-operative system, but the question of "prior rights," comes in, the man first taking the water having first right to its use. And this is a very serious question in times of scarce water especially when many thousands of farmers are using from the same canal, as is the case with the Arizona Canal company, supplying water to the famous Salt River valley, and other similar companies.

There is no likelihood that any other plan than individual irrigation will succeed in Oklahoma, unless it is in the "Nine Mile Flat," near Oklahoma City, or in the bottom lands between Oklahoma City and El Reno, or tracts similarly located.

Having tested the water supply to ascertain what may be depended upon, the next important step is the building of the reservoir. The most convenient size is 100 by 100 feet. Mark the line of the banks and then plow the sod and remove it. Do not put it in the banks. Plow again and from this soil build the banks, about eight feet thick at the bottom and three feet at the top.

[Accompanying the report were suggestions as to the methods of building reservoirs and testimonials to the value of irrigation, copied from different publications. The report closed with recommendations that it be published as a bulletin by the Agricultural Experiment Station, that the Station should try experiments in irrigation, especially west of the Rock Island railroad, that the legislature make provision for the payment of the actual expenses of delegates from the territory to the next National Irrigation Congress, to be held at Phœnix, Arizona, that the agricultural and other papers of the territory furnish as much matter as possible concerning practical irrigation, and that an irrigation convention be held in Oklahoma.]