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Irrigation

for

Maximum Production

War demands conservation of natural resources, as well as efficiency and economy of labor in using these resources. Irrigation water, one of our most valuable natural resources, must be conserved by using it at the right time and in the right amount for profitable crop production.

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Irrigation for Maximum Production

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Economic use of irrigation water is obtained by uniform distribution over the field during irrigation. Careful preparation of the land surface and proper and improved methods of irrigation aid in this uniform distribution of water.

When flooding methods of irrigation are used, the penetration of water into the soil is roughly proportional to the time the water flows over the surface. In long runs where the water takes a long time to move from the head ditch to the end of the run, the upper end of the run is under water longer and the soil absorbs more water than necessary, while the lower part of the run is being adequately irrigated. This loss can be reduced by the use of more field ditches which reduce the length of the run.

Secure Uniform Distribution

Preparation for Irrigation.—A poorly leveled field wastes both water and labor. Water stands in the low spots and is absorbed after the water is off the rest of the field. High spots are difficult to keep flooded long enough to insure good irrigation. The same principles apply to the furrow or corrugation methods of irrigation. Unleveled fields have furrows full of water from ridge to ridge in the low places and a narrow stream in the bottom of deep furrows through the high spots.

Good preparation means that a large part of the labor is done before water is turned into the field. Anyone can successfully irrigate a well-prepared field; an expert irrigator cannot efficiently irrigate a poorly prepared field. Adequate leveling before irrigation saves valuable time in spreading water when time is the limiting factor in determining the amount of land that can be irrigated. This is particularly true when flood rights are being used.

Plan the Ditch System.—Efficiency in irrigation starts with careful planning. The farmer should know intimately the topography and soil characteristics of each of his fields so that he may plan to improve them for better use of his water supply. The field ditches used to distribute the water should be located to fit the ultimate plan, slope of the field, type of soil, kind of crop, and natural field conditions. Where flooding methods are used, the field ditches should be located close enough together so the water will flow from one ditch to the next in less than 1 hour. Where the furrow or corrugation methods are used, the furrows should be short enough so the water will reach the end of the furrows within 2 hours after it is turned into them. Thus, on heavy, clay soil, where water penetrates the soil slowly, the ditches may be several times as far apart as on light, sandy soil where water penetrates rapidly.

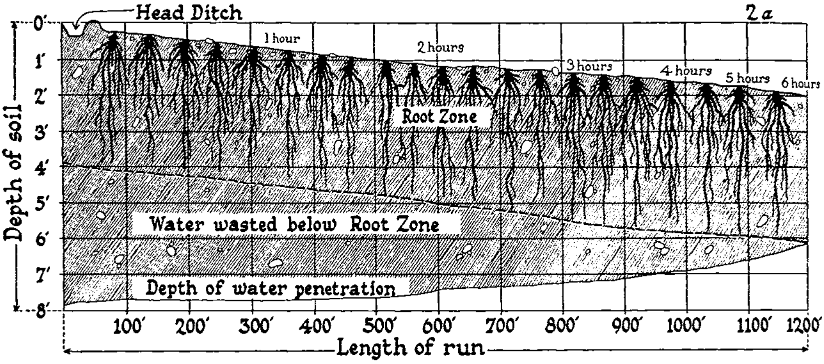


Figure 1

The chart in Figure 1 represents a field of uniform soil and slope 1200 feet long, with one head ditch at the upper portion of the field. To get the water to flow the entire length of the field, 6 hours are required. Thus, the first 600 feet of the field received water from 4 to 6 hours while the last 100 feet received water for 1 hour. As a consequence the water penetrated far below the depth of the roots (rootzone) in the upper part of the field during the time required for it to reach and adequately irrigate the lower end of the field. The water that goes below the rootzone is a serious loss of water and causes valuable plant food to be leached from the soil. The excess water joins the underground watertable from where it may seep out on lower-lying land and cause a seepage area with an accumulation of alkali.

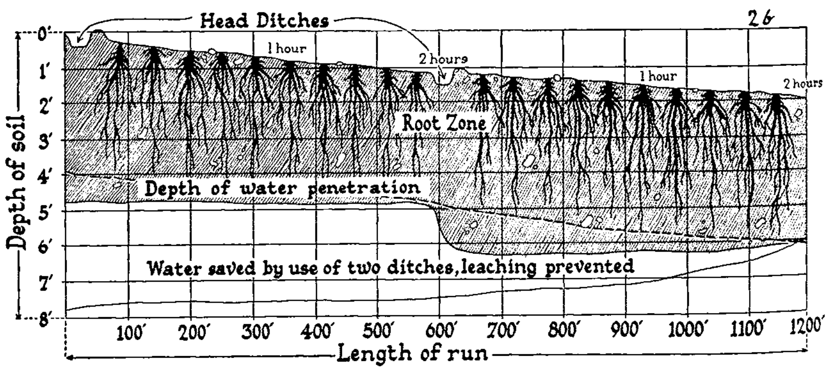


Figure 2

The chart in Figure 2 is the same field shown in Figure 1 with two head ditches. The length of run is reduced from 1200 feet to

600 feet and 2 hours are required for the water to cover each run. The second head ditch collects waste water from the first part of the field and redistributes it to the lower part. The required penetration of the water into the rootzone is secured with very little water or soil fertility being lost, and the time required to irrigate the field is reduced by one-third.

In planning the distribution system, the farmer should consider ways of securing minimum losses and wastes of water and minimum labor in handling and applying the water with proper regard for the use of machinery in other farm operations.

To the knowledge of soils and topography should be added the knowledge of the depth of the soil, the character of the subsoil, the depth to ground water, and the water requirements of each soil and crop. Drastic leveling should be avoided where unproductive subsoils would be uncovered as it takes time to bring them to a state of high productivity.

Clean Ditches.—Clean ditches reduce excessive losses of water by seepage and evaporation. During the entire irrigation season the ditches should be kept free from weeds, trash, silt, and pieces of sod which collect on the bottoms and sides. Clean ditches are particularly important when the quantity of water carried is reduced by a shortage of water which is often the case during the last part of the irrigation season.

Weeds and trees growing on the banks of ditches use large quantities of water and should be removed by cutting or burning at regular intervals. A weedy ditch bank is a source of both weed seed and insects.

Time of Irrigation

The proper time to irrigate is when the crop has used up enough of the water stored in the soil rootzone so that any further drying of the soil will result in a decreased or inferior crop.

Each farmer has his own method of determining when to irrigate. Some use a regular schedule, but the water requirements are different at different stages of growth and under different weather conditions. More water is used and evaporated during dry, hot weather, when the crop has a large leaf area, than in cooler weather when the plants are small.

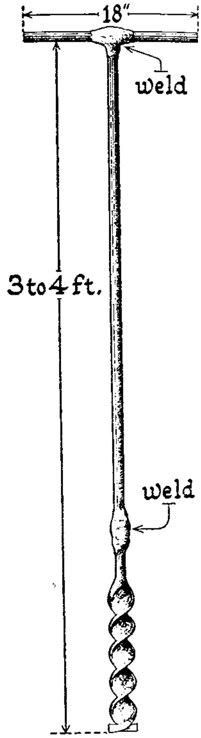
Most crops show a need for soil moisture by a change in color of leaves—turning darker than normal—or by wilting in the hot part of the day. These indications may come too late to be of much value and the crop might suffer before it can be irrigated.

Inspection of the soil is a recommended practice. A soil that will hold together when pressed in the hand usually has enough moisture for continued plant growth. The soil moisture should be observed in several spots in the field and the soil examined to a depth of 3 or 4 feet. The use of a soil auger or post-hole digger to make the examination is recommended. There are usually some spots in each field where the soil has less storage capacity than the rest of the field, and the plants on these spots show a need for water a few days earlier than the plants in the rest of the field. The experienced farmer uses all these indications and makes his decision about when to irrigate from all the available evidence, plus his own good common sense and judgment.

There is one fact to bear in mind, that if a plant suffers from lack of water, yield is reduced even if the plant recovers after an irrigation.

To obtain maximum yields keep the plant healthy and growing vigorously throughout the entire season.

The drawing shows a soil auger made with a steel rod to which an auger bit has been welded.



Soil Auger

Depth of Rootzone Affects Time of Irrigation.—Deep-rooted plants can generally go longer between irrigations than the shallower-rooted plants. Potatoes take between 50 and 60 percent of their moisture from the first foot of the soil, about 25 percent from the second foot, and the rest from the third and fourth feet. This means that potatoes should have frequent light irrigations.

The best quality and yield of potatoes depend on the plants having easily accessible moisture at all times so that the growth is uniform without any checking by scarcity of water. Sugar beets take even more water from the first foot and also require frequent light irrigations.

Alfalfa is a deeper-rooted crop, and less frequent but heavier irrigations are required than for potatoes or sugar beets. Corn is relatively deep rooted and is easily damaged by excessive irrigation. The critical time to irrigate corn is just before or at the time the tassels appear. Late irrigation on corn seldom increases the yield and prevents the corn from maturing properly.

Small grains are shallow rooted, but due to the short time required for them to mature, numerous irrigations are not generally required. When water is scarce and needed for other crops, it is doubtful if it pays to irrigate small grain after the kernels have formed.

Effect of Weather on Time of Irrigation.—Temperature, humidity, sunshine, and wind not only affect the evaporation of water from the soil, but also greatly affect the rate at which water is used by the crop. A few days of hot, dry winds may severely damage crops in case there is not sufficient moisture in the soil to meet the demands. Such days are critical for most crops. In a comparatively short time a crop may receive injuries from which it may never fully recover. A dry period of brief duration may affect yields more than the total amount of water applied to the crop.

Effect of Type of Soil on Time of Irrigation.—Following an irrigation, clay soils may hold 40 percent of their dry weight in moisture, while sandy soil may hold only 10 percent. Coupled with this is a difference in the amount of water left in the soil when plants begin to wilt. A certain percentage of soil moisture—which may be less than 5 percent in sandy soils and as much as 20 percent in clay soils —is held so firmly by the soil particles that it cannot be removed by the roots of the plant fast enough to prevent wilting.

Three to four times the amount of water, available for the use of plants, may be stored in a clay soil, as in a sandy soil during an irrigation. As long as some of this available water is in all parts of the rootzone, crops will continue to grow. As soon as the available moisture starts to become exhausted, irrigation is required. Thus, sandy soils require more frequent but lighter irrigations than clay soils.

Amount of Irrigation.—The amount of irrigation depends on the crop, the soil, and the growing conditions. An adequate supply of soil moisture present at all times is essential. No crop should be allowed to suffer for lack of water.

The soil occupied by the roots of the crop is the reservoir in which moisture is stored for plant use between irrigations. This reservoir has a definite capacity. If more water is applied than is required to replenish the reservoir, the excess, in well-drained soils, is lost through deep percolation.

In soils which do not have good drainage, the excess water fills all the pore space of the soil and causes water-logging which is detrimental to the crop. If less water is applied than necessary to fill the reservoir the top layers only are filled and most of the water applied is lost by evaporation and part of the root system is deprived of moisture.

The time water is left on the field is a poor indication of the amount of irrigation necessary, unless the farmer has an intimate knowledge of his field and crop, and possesses extraordinary judgment. Even then he may be applying more water than required, or the rate of absorption may change more than he anticipated.

Before water is turned on a field the farmer should determine how much of the soil requires water. In many fields abundant moisture may be found in the subsoil and only the upper 2 or 3 feet of the soil require additional water.

While the water is being applied, the farmer can determine how long to let it run by frequent examinations of the soil by digging 2 or 3 feet into it with an irrigation shovel, post-hole digger, or soil auger. A few tests at the upper, center, and lower end of the field, in the rows and in the furrows, will show how far the moisture has penetrated. For most crops and most soils, a 2-foot penetration means that there is enough free water in the upper 2 feet to bring the entire rootzone up to field capacity, or all that it will retain against the pull of gravity.

Too much irrigation water injures the crop and the soil, and is a waste of water and labor. Experience and investigations have shown that up to a certain point more water will produce more crop. The gain per unit of water applied is rapid at first, then becomes smaller until finally additional water actually causes a decrease in yield. **The maximum crop is not necessarily the most profitable** as the water and labor needed to produce the last small increase may cost more than the value of the increase.

With an abundant supply, the saving of water is a benefit to the community as a whole and to the farm individually in reduced leaching of soil fertility and less drainage troubles. With a limited supply, efficiency in irrigation is a necessity. In either case, planning and execution will pay dividends.

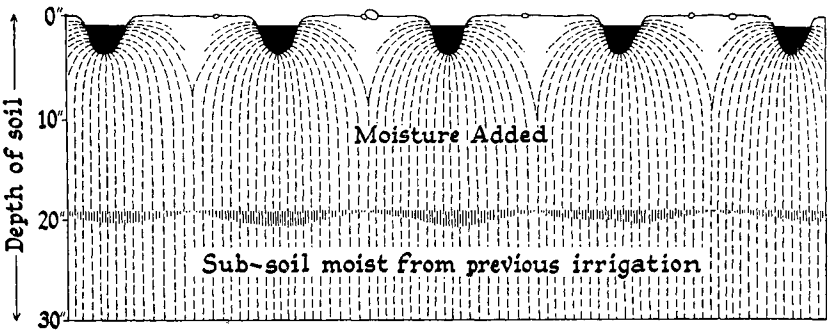
Movement of Soil Moisture

The movement of water within the soil is due to the action of gravity and capillary attraction. Both of these forces act to draw water downward into the soil, while only the force of capillary attraction acts to move water laterally and upward through the soil. In the past and until recent years, the part performed by capillarity in distributing water through soil and in furnishing water to the roots of plants has been greatly over-rated except when the source of supply is a free body of water such as a watertable. When the source is a body of free water or saturated soil, water may move from 15 to 60 inches depending on the soil and other factors. Very little water moves upward into the rootzone unless a watertable exists within 15 to 60 inches below the rootzone.

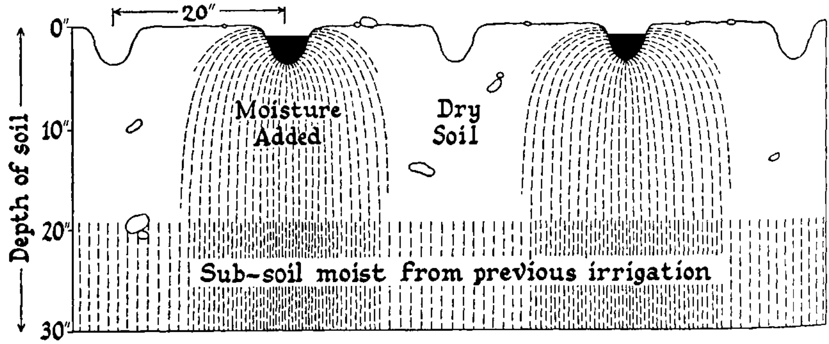
Furrow Methods of Irrigation Depend on Capillarity.—When furrows are used to irrigate, the moisture must move horizontally to moisten the dry soil. The rate of horizontal movement between the furrows is greatly influenced by the type and condition of the soil. This in turn influences the spacing of furrows. The proper distance between furrows for a particular soil is found when the water will moisten the soil between the furrows in the same time required for the water to move downward to the desired depth.

By using only every other furrow in the irrigation of row crops, large quantities of water are frequently lost by both deep percolation and run-off before the entire surface layers of the soil are adequately moistened.

(See next page for charts.)



Water in every furrow for 3 hours—5 to 10 percent run-off and limited losses from percolation.



Water in every other furrow for 6 hours—40 to 50 percent run-off and large losses from percolation below irrigated furrows.

Measure the Amount of Water Applied

It is seldom necessary to apply more than 6 acre-inches of water per acre in a single irrigation. This is equal to a 6-inch rainfall.

The following table shows the time required to apply 6 acre-inches of water on 1 acre with different rates of flow.

Size of stream used Second-feet	Time required per acre to apply 6 acre-inches
.50	12 hours
.75	8 "
1.00	6 "
1.25	4.8 "
1.50	4.0 "
1.75	3.4 "
2.00	3.0 "
2.25	2.7 "
2.50	2.4 "
2.75	2.2 "
3.00	2.0 "
3.50	1.7 "
4.00	1.5 "
5.00	1.2 "
6.00	1.0 "