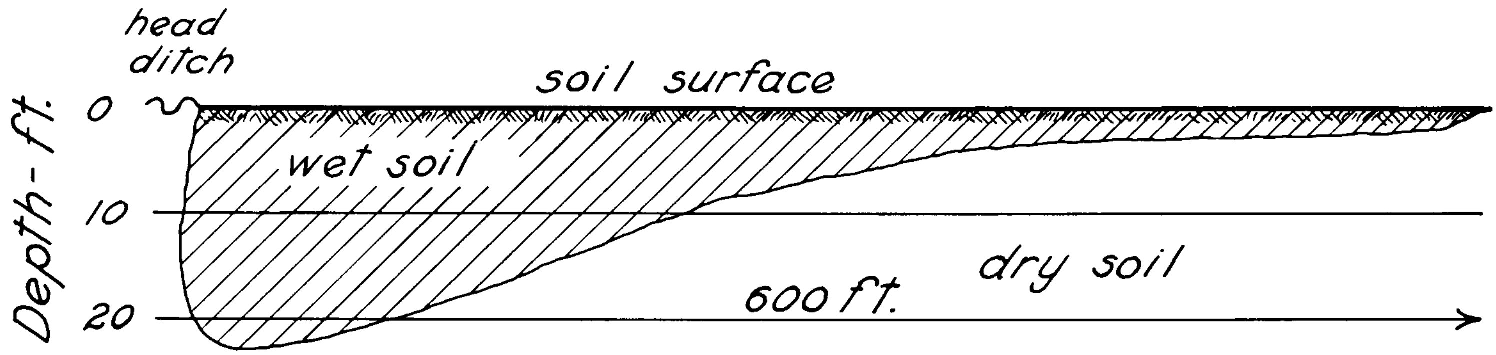


Deep percolation, or waste of water near the head ditch. A small flow of water requires a long time to reach the end of the run.

Economical Usages of Irrigation

The greatest unobserved waste of water is from deep percolation below the root depth of the crop grown.

With some crops, and under certain conditions, 50% or more of the total water applied is lost to productivity by deep percolation.

The length of run in relation to the type of soil and grade is one important condition involved in too deep percolation.

Where the quantity of water is not sufficiently large to reach the end of the furrows or checks in a relatively short time, it usually means that deep percolation is taking place near the head ditch.

If the water reaches the end of the run rapidly, and ponds, the penetration will be deepest at the upper and lower ends of the furrow or check, and least in the middle.

The best results can be obtained by forcing the water to the end of the furrow or check by starting a relatively large head, then reducing it to maintain a flow sufficient only to wet the length of the run until the desired depth of percolation has been obtained.

Maintaining control of water flow is easily accomplished in large checks having valves in the pipeline or permanent gates in irrigation ditches.

In open ditches, where permanent head gates are not used, temporary ones may be installed, or siphons used to take the water from the ditch to the check.

Control of water entering individual furrows from open ditches may be done by placing a short piece of pipe or a small box for each furrow through the ditch bank, or by using a two-inch siphon to transfer the water over the ditch bank to the furrow.

Too frequent irrigation is another important means of wasting water.

Once a soil is at its natural water-holding capacity, more water cannot be held in it, and any excess water will drain through the surface soils and disappear to be lost to the crop by deep seepage.

Economical use of water is to allow the soil moisture to be depleted almost to the permanent wilting percentage before irrigating again. Results have shown that yields are not reduced until wilting or cessation of growth occurs at the time of actual depletion of soil moisture.

Keeping the number of controlled flow irrigations at a minimum reduces surface evaporation and avoids deep percolation.

Reduce Wastage

To reduce water wastage, a grower can check the depth to which the soil moisture has been depleted by the crops before each irrigation. He can also determine the depth of penetration of each irrigation, not only at the head but in the middle and at the end of the run.

To check the soil moisture, an auger or soil tube can be used before and immediately following an irrigation—or, in the absence of hardpan or clay-pan a probe may be used.

The probe is a small, pointed iron rod, one-fourth to three-eighths inch in diameter, which can be thrust easily into the soil to the extent of the depth wetted, but will not readily enter the dry soil.

If a soil is dry, it should be preirrigated to the depth of rooting of the particular crop to be grown, with the exception of those crops that are irrigated at the time of transplanting, such as tomatoes.

Soils having had an irrigated crop growing on them the previous fall should be checked for soil moisture. Even with limited rainfall sufficient soil moisture may be carried over from the last year's irrigation to provide moisture to the depth of four to six feet.

Alfalfa

Alfalfa roots to a depth of 10 to 12 feet with a water requirement of about 30 inches per year at Davis, in addition to the normal rainfall. This water requirement will increase when the crop is grown under warmer and drier climates.

There is not much danger of overirrigation unless the crop is irrigated two or three times per cutting. Where penetration is poor and on very sandy soils, two irrigations per cutting may be necessary.

Most of the savings in water that can be made for this crop are involved in adjusting the head to get an even penetration through the length of the check. If it is necessary to eliminate one irrigation the last one may be omitted without affecting the next year's yield.

If the soil moisture is deficient in midseason and growth is checked, an irrigation immediately following the cutting will produce a normal yield of hay at the next harvesting. The loss of hay will be proportional only to the length of the drouth.

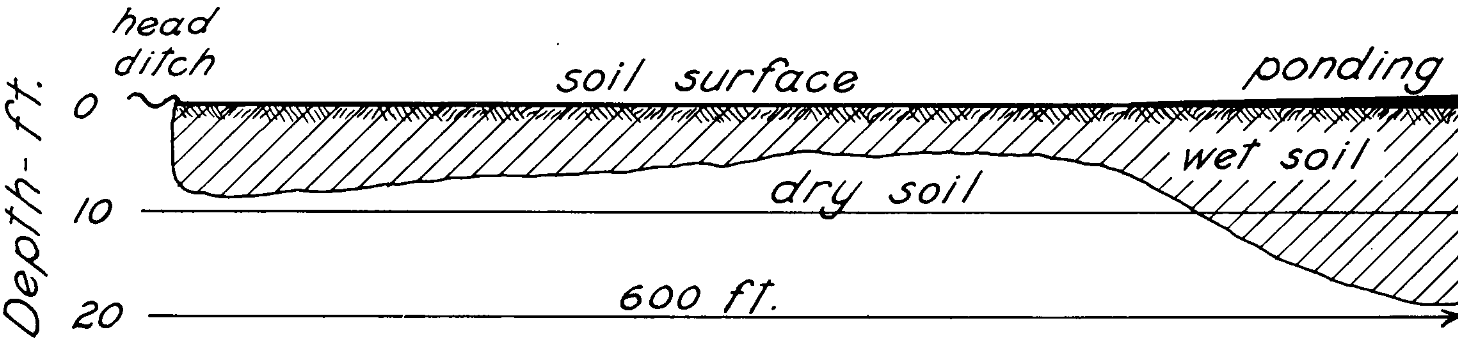
Sugar Beets

Sugar beets root to a depth of five to six feet and with normal rainfall the requirement in the Sacramento and San Joaquin valleys is about 24 acre-inches. If the soil is dry at the time of planting, an additional six or eight inches may be necessary as a preirrigation.

Sugar beets may be considered a good risk crop. If the water supply is limited in July and August the irrigations may be withheld without injury to the crop produced up to that time.

Growth will be retarded when wilting begins. On a heavy soil where beets have been wilted for a two- or three-week period, 3% or 4% increase in sugar content will occur. Where such a period of prolonged wilting exists, approximately half of the leaves may be lost.

In hot climates on light sandy soil, sugar beet leaves die within a few days after wilting starts and in this case it is



Deep percolation from ponding at the end of the run. Too large a flow was used with resultant ponding and wasting of water.

Water for Field and Truck Crops

L. D. Doneen

questionable whether the increase in sugar percentage will occur.

If a shortage of water occurs in the summer months, it would be better to lay aside a portion of the poorer and less fertile parts of the field and not irrigate them, than to have intermittent wilting with death of the older leaves in the whole field.

Once it has been decided to withhold water on part of the field, irrigation should not be done until after the beets are seriously wilted. An increase in sugar percentage will result from wilting, but with irrigation this high percentage will drop and a resumption in growth of the beet is slow.

Tomatoes

Tomatoes will root to a depth of nine to 12 feet and require about 18 inches of water at Davis, provided the surface six feet of soil is wet at the time of transplanting.

If the soil is not wet to this depth at the time of transplanting, two furrows should be used for the irrigation immediately following transplanting—one next to the plant and another between the rows. Even later in the season, where practicable, it would be economical to irrigate with two furrows between rows.

Tomatoes need not be irrigated until June on good deep soil. In July and August the water requirements are greater than in June and the depth of application should be greater.

By the end of August, all of the soil should be wet to a depth of seven to nine feet in order to carry the plant through the September and October picking season without additional irrigations.

If this cannot be accomplished it would be advisable to irrigate after the first or second picking, for if the plants do not have available water during this period, the fruit will not reach sufficient size to make a commercial picking and yields will be reduced greatly.

Water cannot be withheld during the latter part of the tomato season without losing a large percentage of the crop. In case of a water shortage, growers who have beets and tomatoes can sacrifice the beets in August with only a small loss in growth and apply the extra water to the tomatoes.

Cotton

Cotton will root and use water to a depth of four to five feet. Although considered a long-season crop, water requirements are relatively low in late fall and early winter. Months of highest water requirements are July and August. On sandy or shallow soils it may be necessary to irrigate in June.

A successful cotton crop may be grown with 18 inches of water not including the preirrigation. If a shortage of water occurs during the latter part of the growing season, vegetative growth may be checked, but yields may not be materially reduced unless the drouth is prolonged and severe.

Slowing of growth due to water shortage usually causes a high percentage of bolls to mature and yields are fairly well maintained. Cotton may be considered a low-water-requirement crop for the area in which it is grown and is a good one with which to gamble in case of a water shortage.

Lima Beans

This and other vining-type crops are relatively deep-rooted—four to five feet—and in the inland areas require about 12 inches or less water if the soil is wet to four feet at the time of planting.

Good yields have been obtained from two irrigations. The bulk of the crop is produced on the basal set and if the plant is short of water after the set is made, yields will not be severely reduced.

Milo

Milo has been grown successfully on medium to heavy soils in northern California without irrigation when the soil is wet to six feet or more.

One irrigation will assure good yields on deep soil. On sandy soil and in the warm climate of the San Joaquin Valley, several irrigations are necessary, but the water requirement is 12 inches or under. Milo is a good crop to plant in late spring or early summer because of its low water use.

Melons

Whether planted early or late, melons have a low water requirement due to the short time the vines cover the ground.

Watermelons root to six feet or deeper and cantaloupes to about four feet. In either case, an acre-foot or less of water is all that is necessary to produce a crop provided the soil is wet to a depth of four feet or more at the time of planting.

Shallow or Weak-rooted Crops

Such plants as onions, lettuce, potatoes, corn, bush beans, and ladino clover usually require frequent irrigations and generally considerable water is lost through deep percolation. A good potato crop, for instance, may be grown with 18 inches of water where hardpan or poor penetration prevents deep percolation. On the more open soils, two or three times this quantity is required.

Most potatoes are grown on light sandy soils, but when grown on loam or clay loam soils, they need not be irrigated as frequently as on sandy soils.

Continued on page 16

ARTIFICIAL SHADES

Continued from page 5

followed the same pattern as the rates of gain. Salt consumption was normal in every case.

Ground Radiation

Ground heat radiation is of importance and must be considered in the problem of animal comfort in warm climates.

The flat plate radiometer indicated that in August, near mid-day, when the solar and sky radiation was at a maximum, the radiation from the ground to the under side of the cattle was from 50% to 60% lower. This was for areas of unvegetated hard ground away from the shade, no part of which had been in shadow during the day. The air velocity varied from 150 to 200 feet per minute.

Under the shades the radiation from the lower hemisphere—under the cattle—at the same time of day, was about the same as from the upper hemisphere—above the cattle.

The lowering of the temperature of the concrete under the aluminum shade by the water was of marked benefit in lowering the the amount of radiation.

On two adjacent plots, each 200 feet square, the air temperature over one—an alfalfa field—averaged 5° F lower at midday than over the second plot—plowed ground. The lower hemisphere radiation over the alfalfa plot was 30% as great as the upper hemisphere or sky and solar radiation, but over the plot of plowed ground it was 40%, as measured by the flat plate radiometer.

It may be possible to increase the animals' comfort by selection of the proper type of ground surface. For instance, at 11 a.m., on a day when the air temperature was only 89° F the following temperatures were observed in the sun:

Hard ground, tramped by cattle	124° F
Hard ground, in road	129° F
Soft ground, not tramped by cattle	132° F
Dry rotted manure in feed lot	148° F

Evaporation

Three shower heads were installed under the aluminum shade from July 28 to August 14. They gave a fine mist spray under 30 pounds pressure.

The cattle made little use of it and did not appear to be getting any beneficial effects from either the sprays or the wet floor.

From August 14 to September 14, only one shower head was used, but the hole was enlarged to give a coarse spray and the head brought down to within six feet of the floor.

The cattle began to make more use of the coarse spray and towards the end of the test one animal was using the shower as much as three hours a day.

Under the mist spray the animals got only a superficial dampening, but with the coarse spray they were wet to the skin. This soaking caused a decided drop in respiration rates and body temperatures. Wet animals quite often had body temperatures 2° to 3° lower than did dry animals and respiration rate drops of 20 or more per minute were noted a number of times a half hour after the cattle got wet.

Even when night temperatures did not drop below 80° F the heifers would not use the showers at night. Their use was confined to the late morning and most of the afternoon.

Convection and Radiation

Heat loss by convection and radiation in a given environment is also controlled by the surface temperature of the animal.

It is possible to approximate the heat interchange between an animal and its environment by using some of the data obtained as material for calculation. Calculating the net exchange by radiation we find that an unshaded cow is receiving 2,423 British Thermal Units more per hour than she is emitting, and that a cow under the shade is emitting 340 more BTU's per hour than she is receiving. It should be remembered that the situation has been idealized for calculation purposes by considering the cow as having flat surfaces.

Convection

An approximation of heat exchanged by convection also can be made by calculation.

The radiation and convection exchange can be summarized as follows:

Heat exchange	*Unshaded cow*	*Shaded cow*
By radiation (BTU per hour)	–2,423	+340
By convection (BTU per hour)	+1,856	+437
	–567	+777

The negative sign (–) indicates heat movement into the cow and the plus sign (+), movement away from the cow. The unshaded animal must lose a total of 1,344 BTU's more heat per hour than the shaded heifer, by vaporization—the sum of 567 and 777. This is equivalent to the evaporation of 1.3 pounds of water.

Studies to Continue

The investigations at Meloland Field Station will be continued in the summer of 1948.

A larger number of cattle will be available for the tests and more shades are being constructed.

The effect of shade size and height, louvres in the roof, cooling of walls and roof by evaporation, and the evaporative cooling of air, will be studied.

The subject of ground radiation will be given more attention.

A model weather station will be installed and the records obtained will allow for a correlation between the weather and the environment as modified by the shades.

The effect of radiation and air temperature on the surface temperature of the animals will be determined in greater detail.

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Cattle standing under shade covered with 1″ x 10″ boards spaced 1″ apart. Air temperature 103° F and ground temperature in shadow 104° F. In unshaded strips between board shadows, ground temperature was 148° F. High ground temperature may be reason for cattle not lying down.