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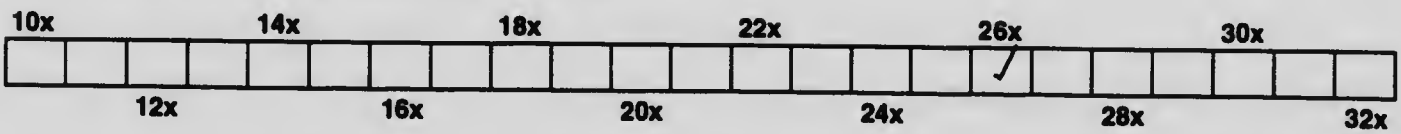

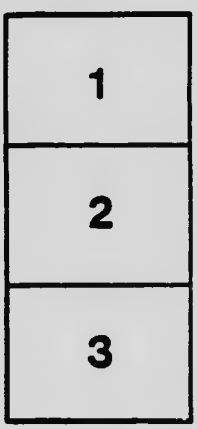

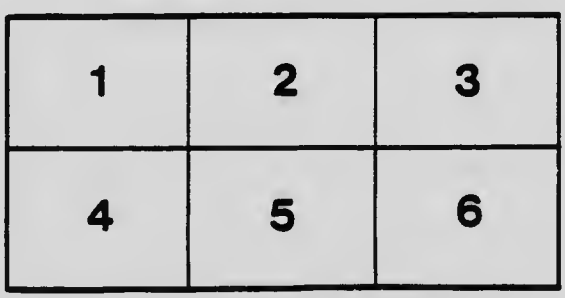

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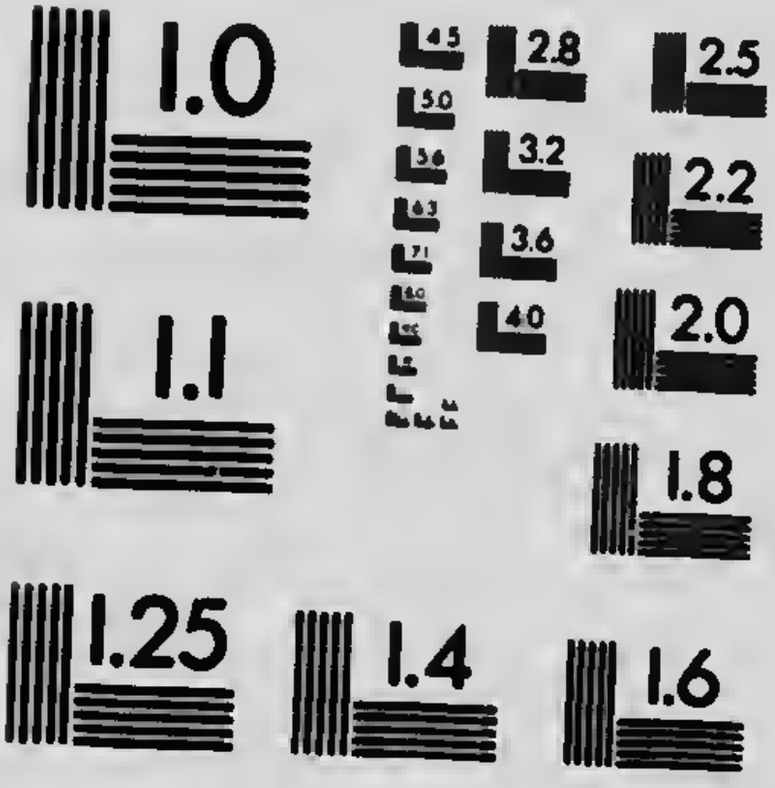

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CIRCULAR No. 14.

PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE (HORTICULTURAL BRANCH).

PRACTICAL IRRIGATION.

By H. Thornber, B.S., Assistant Horticulturist.

BY irrigation is understood the economical distribution and use of water on arid or semi-arid lands. Irrigation in itself is not difficult, but is merely the application of known principles. Any man who has had experience with growing plants may in a short time become very proficient in the use of water.

UNDER WHAT CONDITIONS NECESSARY.

Irrigation is necessary where there is a deficiency in the rainfall, either at all seasons of the year or during the growing season. Water is an absolute necessity for plant-growth. It not only serves as a food, but acts as a means by which other plant-food is conveyed from the soil into the plant. If an adequate supply of water is not available by precipitation or other natural means, irrigation should be practised. During an exceptionally dry year or a short period of drought, many farmers feel the need of a little water to help their crops mature, but since the demand does not come every year or the water-supply is not available, they do not supply the needed water. The advisability of preparing for such an emergency depends upon the frequency of the drought and the expense connected with such an undertaking.

Some sections of British Columbia, like the Nicola Valley, the Okanagan and Kamloops Districts, and points on the Arrow and Kootenay Lakes, depend upon irrigation to a greater or less degree for their water-supply. Without this means of supplying water, much of this land would be unproductive. The advisability of irrigating this land is shown by the immense returns produced under the present systems.

THE CONSTRUCTION OF THE DITCHES.

In most large irrigated sections the water-supply is under the control of the Government or private corporations. However, if the supply is to be secured by private enterprise, the farmer must make use of available sources, such as natural springs, lakes, rivers, creeks, or wells. It may be necessary to build ditches of various lengths to carry the water from its point of origin to the land. Co-operation between several land-owners will reduce the cost of building such a ditch to a minimum. The water should be carried to the highest points on the land to be irrigated, and distributed by means of small lateral ditches or flumes. Since the loss by seepage from an open ditch is great, the use of wooden or cement flumes is advisable whenever possible.

These are not only fairly permanent and economical of water, but permit complete control of the water when irrigating. The flumes from which the water is to be delivered into the furrows should be placed at intervals of about 25 rods. The size of these flumes varies from 6 to 10 inches; however, the 8-inch flume is the size most commonly used. The water is drawn from these flumes by means of 1-inch holes placed at intervals of about 3 feet. The supply is regulated by a tin or wooden slide nailed over the hole. If these slides are placed on the inside of the flume, there will be much less danger of them becoming blocked, but this will require the wetting of the hands each time they are adjusted.

In clean cultivation with young trees a furrow is made on each side of the row, and in old orchards the space between the trees is furrowed at intervals of about 6 feet or even closer in sandy soil. These furrows are made about 4 or 6 inches deep with a small plough or single-shovel cultivator. The Oliver Double Mould-board No. 2 marking-plough has been found very valuable for making these furrows.

The slope on which all ditches or flumes should be built is of great importance. It is a common fault for a beginner to get the fall too great. One inch to 25 feet is plenty. However, if the contour of the land demands a greater fall, the progress of the water may be checked by means of small stones or short lath "stops" placed across the flume.

The minimum fall for furrows between the trees should not be less than 4 inches to each 100 feet for clay soil and 8 inches for sandy soil. The maximum fall is governed by local conditions. If the land is very steep the furrows must be made on the contour and not up and down the hillside.

THE ADVANTAGES OF WATER UNDER PRESSURE.

So far the use of water from open ditches has been discussed. In many districts people are placing water under pressure, and the results show it to be a very commendable plan. The pipes used to carry the water are made of wood or concrete and are placed underground. Small 1-inch iron pipes with stop-cocks extend up to the tree-rows from the underground lines, from which the water is drawn. These pipes should extend a foot above the surface of the ground and be placed near a tree, so as not to hinder cultivation.

The advantages of this system are as follows: (1) It does away with the open ditch and flumes, permitting the farmer to cultivate his orchard and harvest his crop at a decreased expense; (2) it permits water to be forced to higher points according to pressure; (3) although more expensive to install, is nearly permanent, and if well built requires little expenditure to keep up; (4) it prevents loss of water by seepage or evaporation; and (5) permits the water to be piped into the house and barn for domestic use.

PREPARATION OF THE SURFACE.

Nothing can be gained by attempting to irrigate and till the land before it is well prepared. A few dollars spent in the beginning will often save twice that amount during the first few years. Unless the land is well prepared and allowed to settle, it is impossible to secure uniform results, because the low places will be flooded while the high points are still dry.

The land should be cleared of all stumps, rocks, or sage-brush, and then ploughed as deeply as possible. If more rocks come to the surface during the process of ploughing they should be removed. The high places should now be graded down and the depressions filled, care being taken not to remove all

the good soil from the high points in the attempt to fill the low places. The Fresno scraper should be used where a large amount of earth is to be moved. In case the soil on the high points is shallow, the upper part may be removed and returned after grading is completed. This may seem to be a lot of work, but is absolutely necessary in some cases. In case this is not possible, good rich soil should be used to fill the tree-holes. This will give the young trees a good start and also permit the newly uncovered soil to become congenial for the tree-roots when they are ready to occupy it. After the large depressions are filled the work of levelling is continued by means of the leveller or float. This is a device 18 feet long and 7 feet wide, which may be made at home. Take two pieces of timber 2 by 10 inches by 18 feet and four pieces 2 by 10 inches by 7 feet. Place the two long pieces parallel 7 feet apart, with the four short pieces distributed at intervals of 5 feet between them. This leaves 1½ feet at either end for hitching, which is done by boring holes in the end and stretching a chain across. Larger models of this machine may be made by keeping the same proportions. The machine described requires four horses for the best results. Various braces and foot-planks may be added as needed. (*See* Fig. 1.)

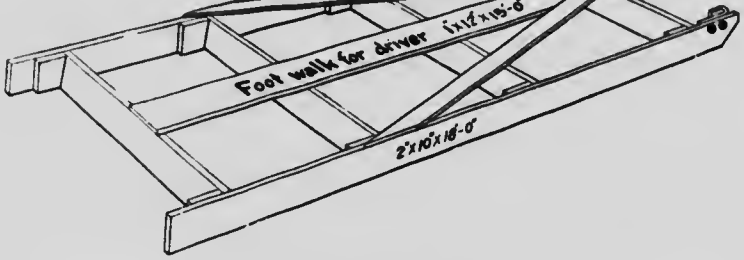

Fig. 1. Leveller or float.
(Farmers' Bulletin 392, U.S. Dept. Agr.)

B[illegible]is device have the surface of the soil loose and as free as pos[illegible] rocks. Run first lengthways, then crossways, the driver riding on the leveller while on the high places and dismounting while crossing the low places. This makes it fill and empty at the proper time. Much depends upon the driver for the best results; three or four times over the field should leave it in good condition.

METHODS OF APPLYING THE WATER.

One of two methods will be found very practical in applying water to land. Various modifications may be employed for special cases, but the furrow system for orchards and gardens and a combination of the furrow and flooding systems for meadows will be found ample. The furrow system, which is the most common in British Columbia, may be used on the land with less preparation than any other practical system. The land need not be level, but merely sloping enough to give a good fall without any swales or extra high places; of course, the less there are of these the better.

THE APPLICATION OF THE WATER.

Having the levelling done and the ditches and flumes constructed, the process of applying the water is simple. The water is permitted to enter the lateral ditches or flumes and the small gates are opened. As the water creeps down the furrows the irrigator must watch to see that no furrows become blocked or run together. The time required to finish irrigation varies from three days to a week or more, but may be determined by the methods mentioned in paragraph on "Amount of water to use."

In case the land is newly graded it should be well irrigated to settle the loose places before planting is started, or great difficulty may be encountered. It is a good plan to place clover or some crop on the land one year previous to planting. This not only permits it to settle, but also enriches the soil.

THE FREQUENCY OF APPLICATION AND THE AMOUNT NEEDED.

The frequency of application and the amount needed depend upon the crop, soil, and climatic conditions. Some crops need more frequent applications of water than others. The frequency of application must be such as will keep the plants in a thriving condition and still not cause too rapid a growth. A sandy soil needs frequent applications of water because it loses moisture by drainage and evaporation, while a clay soil is very retentive and holds water long after the sandy soil is dry. One application of water during the late summer is often sufficient in a semi-arid district. Where one depends entirely upon irrigation, more applications are necessary. In case there is little rain in the spring, the first water should be applied about the 1st of May and about every five weeks until the crop is mature. More frequent irrigations may be needed on some lands; this may be determined by the amount of available moisture in the soil. Cultivation should follow each irrigation and should be repeated every ten days or two weeks until the next irrigation. Do not think for a moment that irrigation can be made to take the place of cultivation, because it is not advisable and will injure the soil.

The quantity of water to use at each irrigation is a local problem and must be determined by experience. In general, if the crop is a deep-rooted one, more water is needed than for a shallow-rooted crop, because of the necessity of soaking up the upper layer of soil before reaching the plant-roots. It has been found that 4 inches of water applied to land at one irrigation makes the first 4 feet of soil moist enough for good plant-growth. However, this is not absolutely correct when applied in practice, because of the loss of water by drainage and evaporation. Since the practical farmer has no way to determine the exact amount of water he has applied, he must rely upon other methods to determine when enough water has been applied. This is easily done by a few observations. Many people make this test by pushing a hoe-handle into the soil. If they can sink it down 18 inches they consider irrigation completed for that time. Another method is to dig down and examine the soil. If it retains its form when compressed in the hand it is considered moist enough. Tests of this nature should be made at intervals over the field, since different soils need more or less water. After a few trials, any one can tell for himself whether or not enough water has been applied. In case a person still feels in doubt about the amount of water necessary for the best plant-growth, an examination of soil upon which plants are doing well will remove all doubts from his mind.

THE MEASUREMENT OF WATER.

The need for the measurement of water is not felt where there is an abundance for all the land-owners. This condition exists in a very few places and is becoming less common each year. Even where an abundance of water is available, some system of measurement would enable the irrigators to prevent a large amount of the damage done to crops and soil under the present systems. As time passes and more land is brought under irrigation the supply of water will not be so abundant; hence the great need of some knowledge of its correct measurement.

There are several units of measurement; some are used for flowing water and some for water at rest. The "cubic foot per second" or the "second-foot" is the standard unit of measurement of flowing water, while the "miners' inch," although not common, may be used to advantage where a small amount of water is to be measured. One cubic foot per second is equivalent to 35.7 British Columbia miners' inches. The "acre-foot" is the unit of measurement for large bodies of water at rest. An acre-foot of water may be defined as that amount necessary to cover one acre to the depth of one foot; or is equal to 43,560 cubic feet. One acre-inch is equivalent to one-twelfth of an acre-foot, or the amount of water necessary to cover one acre one inch deep.

Care must be taken so as not to confuse the terms mentioned in the measurement of water. The cubic foot and the miners' inch indicate a rate of flow, and in order to determine the amount of water it is necessary to consider the time or duration of flow.

The following table, which is taken from Bulletin 44 of the Department of Agriculture, will show the relation between the different units of measurement:—

1 cubic foot per second is equal to 35.7 miners' inches.

1 cubic foot per second is equal to 6.25 Imp. gallons per second, or 7.5 U.S. gallons per second.

1 cubic foot per second will give in one minute, 375 Imp. gallons, or 450 U.S. gallons.

1 cubic foot per second will give in 24 hours, 2 acre-feet (approximately), or 1 acre-inch in one hour.

1 British Columbia miners' inch will give in one minute, 10.5 Imp. gallons, or 12 U.S. gallons.

1 British Columbia miners' inch running for 36 hours will give 1 acre-inch.

In British Columbia a miners' inch consists of the quantity of water which will pass through an orifice 2 inches high and ½ inch wide made in a 2-inch plank, the water to have a constant head of 7 inches above the upper side of the orifice. Each additional inch requires an extension of the above orifice ½ inch horizontally.

Where water is to be measured by the cubic foot per second or second-foot, a weir-box will answer the purpose very well. The most common type is the "trapezoidal" weir-box, a drawing of which is shown in the following diagram. This may be placed in a stream, or a portion of the stream may be diverted through it. In this diagram the weir-crest is 12 inches long and the notch is 7 inches deep; the sides slope out from the weir-crest 1 inch for every 4 inches rise. The wings and cut-off aprons, as shown on the ends of the weir-box, prevent the water from washing around or under the box. These weirs may be made of wood or concrete, and should be shaped level where the water strikes them squarely, otherwise they will not give accurate results.

The accompanying diagram (Fig. 2) will enable the reader to get an idea as to the exact structure of a miners' inch box.

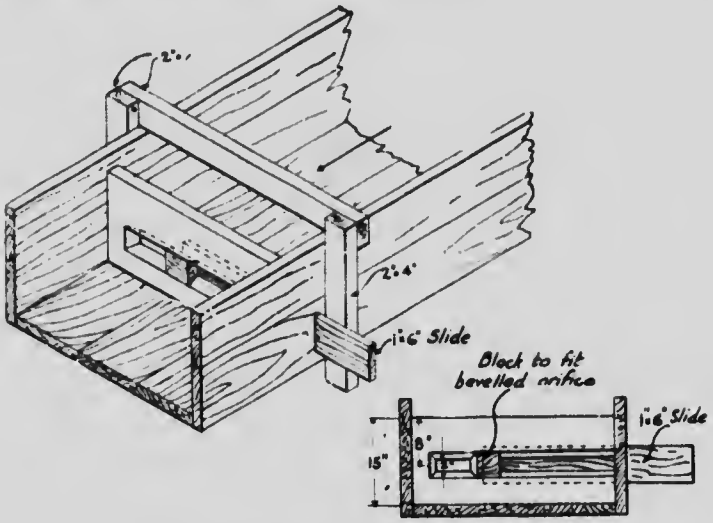

Fig. 2.—Miners' inch measuring-box.
(Bulletin 44, Dept. of Agr., B.C.)

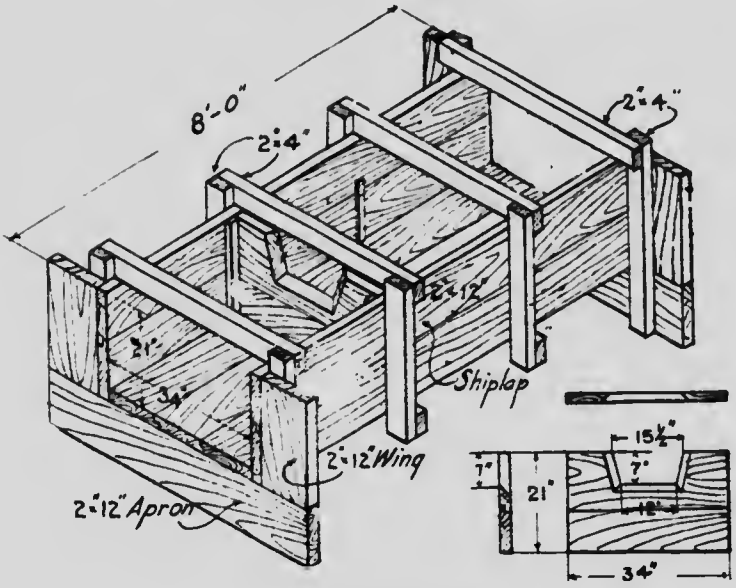

Fig. 3.—Trapezoidal weir-box.

The following is a table of discharge for a 1-foot Cippoletti or trapezoidal weir. It may be used for longer weirs by multiplying the quantities given by the length of the weir in feet:—

TABLE OF DISCHARGE FOR A 1-FOOT TRAPEZOIDAL WEIR.

Depth of Water on Crest in Inches.	Cu. Ft. per Sec.	Miners' Inches.
1	0.08	2.9
2	0.23	8.2
3	0.42	15.0
4	0.65	23.1
5	0.91	32.3
6	1.19	42.5
7	1.50	53.5
8	1.81	65.0

In order to secure the most accurate results, the depth of water allowed to pass over a weir should not exceed one-third the length of the crest; the limit for a 12-inch crest being 4 inches, a 24-inch crest 8 inches, and 12 inches for a 3-foot crest.

AMOUNT OF LAND ONE MAN CAN IRRIGATE.

This is rather a difficult question to answer because of the variation found in different locations. The crop grown, soil, contour of the land, and ability of irrigator limit the amount handled by one man. If the orchard is in clean cultivation, one man should handle from 30 to 50 acres. This may seem a large area to some men, while to others it will appear very small. However, a small area well cared for is better than a large area neglected.

RELATION OF IRRIGATION TO TILLAGE.

In a previous paragraph mention was made of the importance of cultivation after irrigation. Since this is a very important point, the writer feels that it should be given special attention.

Tillage serves for two main purposes in its relation to irrigation. First, tillage prepares the land for the reception of the water and, second, for its conservation. It is plainly evident that loose soils will absorb more moisture than packed soil. Clay soil should be given deep cultivation previous to irrigation in order to make it more receptive to water, while sandy soil seldom needs much cultivation previous to irrigation because it does not cement together like clay soil.

After irrigation all soils should receive surface cultivation to a depth of 4 to 6 inches. This is done by means of a common harrow, and should be repeated at intervals of from ten days to two weeks and after every rain until the next irrigation, as indicated in a previous paragraph.

COSTS.

The question of vital importance to the man planning on placing his land under irrigation is: "How much will all this work cost?" This question cannot be answered offhand. Every farm is a problem in itself. Some land may be brought under for as little as $4 or $5 per acre, while other land often costs $100 per acre. Estimates on the cost of grading and ditch-construction work may be secured from men who follow this work as a profession.

In general the cost of clearing, levelling, and construction of ditches ranges from $25 up to $40 per acre. This varies according to cost of labour and material and to the conditions confronted while doing the work. Any man who can do the work himself need not fear the costs, because it is all of a practical nature and requires little experienced aid. Many new and valuable ideas may be obtained by watching other people engaged in similar work.

SPECIAL POINTS TO REMEMBER.

(1.) Have land in good condition before attempting to irrigate.

(2.) Thorough applications of water at long intervals are better than light applications at shorter intervals.

(3.) Over-irrigation is more common than under-irrigation; beware of getting your soil water-soaked.

(4.) Have good drainage to prevent the accumulation of salts by evaporation of water from the surface.

(5.) Cultivate as soon as possible after each irrigation, and every ten days or two weeks and after every rain until the next irrigation.

(6.) Have land free from trash.

(7.) Even though you have more water than you need, don't use it; it is poor economy and may lead to disastrous results.

CONCLUSION.

In this circular the writer has attempted to cover the main points and to make it as practical as possible, since he understands that the ordinary irrigator has neither the equipment nor time to make extended investigations. The reader must not feel that the methods mentioned above are the only ones, because they are not. Many systems are much more complicated and require a great amount of capital to install and operate. The ones mentioned in this circular are practical, economical, and have been found to be very efficient.

For further details on the subject of irrigation in British Columbia the fruit-grower will find Bulletin 44, which may be secured upon request from the Department of Agriculture at Victoria, to be of great value.

Victoria, B.C., December, 1912.

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