

INFILTRATION RATES AS A GUIDE IN DESIGN OF FURROW IRRIGATION SYSTEMS

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Introduction

In many cane growing areas, sprinkler irrigation systems may well be the best means of applying water. However, there are areas where both topography and soil type will permit the use of efficient flood irrigation. In these circumstances, there is need for a sound basis on which to decide the length and grade of furrows to be used. The governing factor is quite obviously the rate at which the soil absorbs water, but a problem which needs to be solved is how to measure this accurately and with confidence.

Review of Intake Rates

To measure the intake of water into a soil, single or double ring infiltrometers are widely used in most countries. These, however, measure only the intake rate on flat surfaces, hence where furrows are used this system needs to be modified. When water is applied in rows, the pattern of water absorption differs considerably from that experienced when an area is flooded. Thus, for an equal area of water surface there is in the furrow a greater area of wetted soil surface. In addition, one of the objects of row

irrigation is for water to move laterally or even upwards and this contrasts with the pattern measured with a ring infiltrometer, where every effort is made to eliminate all lateral movement.

In the U.S.A., after long and exhaustive research, recommendations have been made on the volumes of water which must be used for furrow irrigation. The data so obtained quotes volumes which appear to be extremely low for soils and conditions in the subtropics. Thus, in Rhodesia, streams which are ten times greater in volume were necessary for soils of similar intake rates and grades. In fact it was only in soils with intake rates as low as 0.1 in. per hour, that recommendations developed in the U.S.A. could be used.

Use of Data

Water flowing down a furrow or terrace follows a regular pattern of movement. At first the speed of the water is rapid but it gradually slows down and eventually it reaches a point where it moves no further, indicating that the intake along the furrow balances the amount of water being fed into it. See Fig. 1.

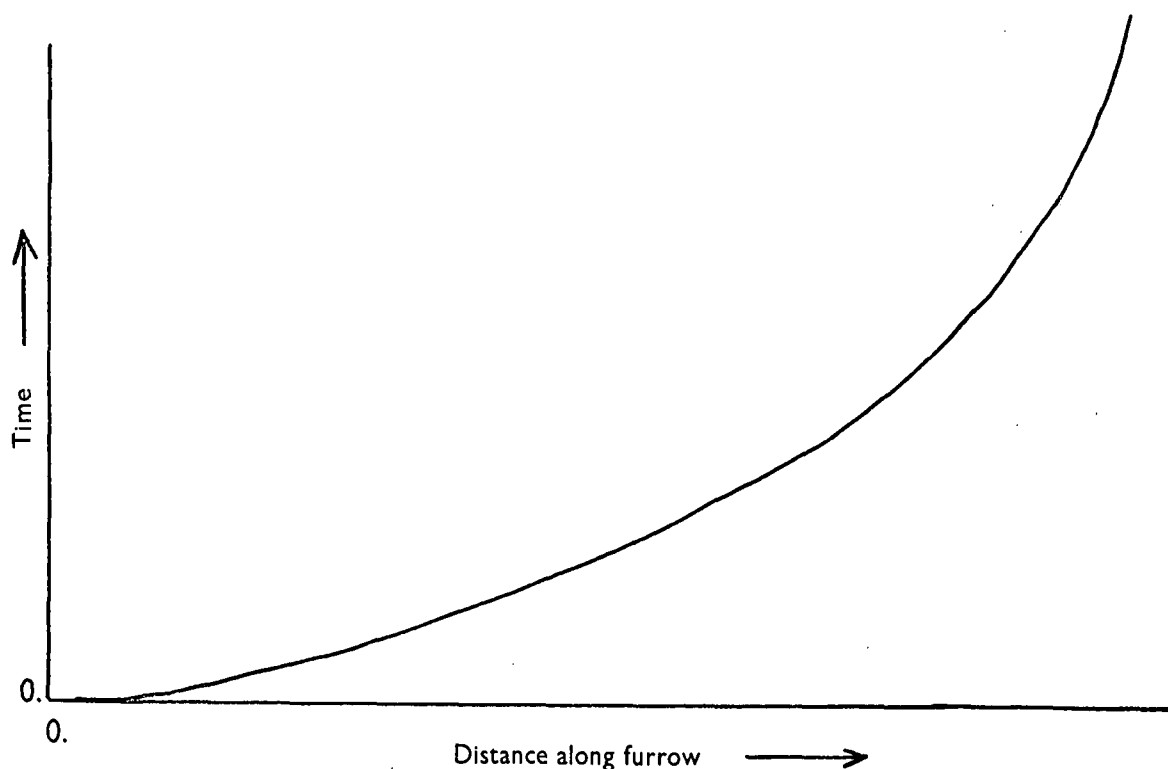


FIG. 1 Typical Graph of Flow of Water down Furrow

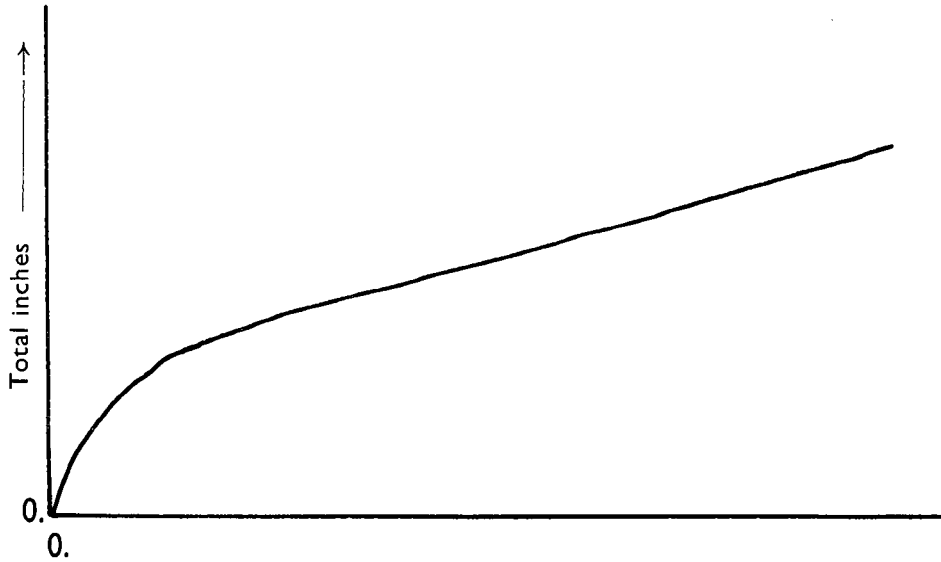


FIG. 2 Typical Graph of Water Absorbed by soils
Time →

The rate of water intake by a soil changes with time, as illustrated in Fig. 2.

At first, water is absorbed very rapidly, but later the rate of absorption slows down, until it reaches a fairly constant level. It is this pattern of decreasing absorption which allows intake rates to be used in the

design of irrigation schemes, to ensure efficient application of water.

When water flows along a furrow, the pattern of absorption is as illustrated in Fig. 3. If intake had not followed its characteristic curve, but remained constant, then the pattern of water absorption would have been as shown in Fig. 4.

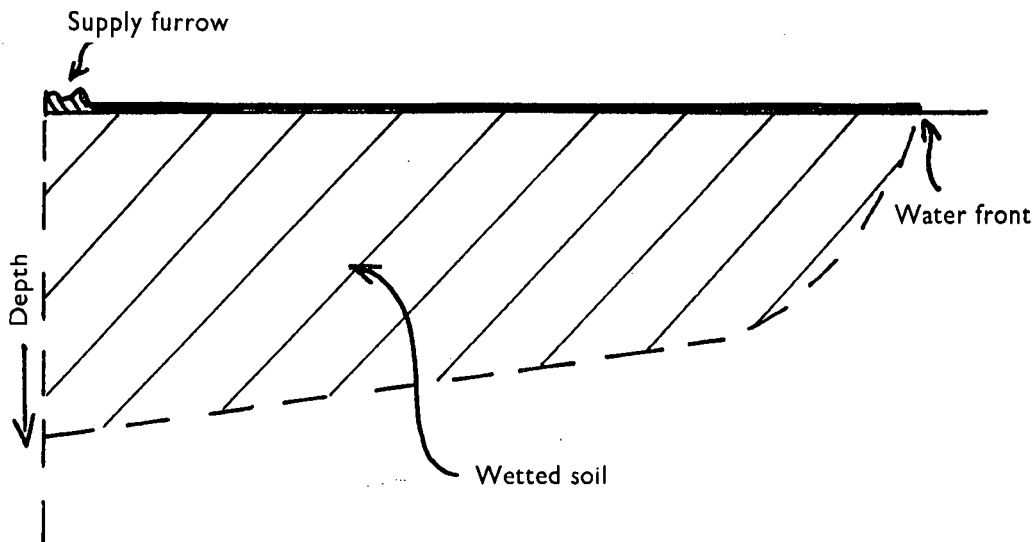


FIG. 3 Pattern of water absorption along furrow

Measurement of Water Absorption in Furrows in Rhodesia

After examination and testing of systems developed overseas, mainly in the U.S.A., it was decided to use a modified system of measuring infiltration in the furrow. The row infiltrometer used consisted of four steel plates pushed into a length of furrow, thereby forming three chambers. The two outer chambers acted as buffers, while the actual measurement of water absorption took place in the inner chamber.

In contrast to the ring infiltrometer and due to the different pattern of water absorption, measurement of a drop in water level is not a suitable guide to infiltration rate. In its place, measurement of the volume of water is required. In the field, each furrow is supposed to serve an area which is a measure of its length times its distance from the adjacent furrow. In the same way, the centre chamber of the infiltrometer serves an area which is the spacing of the furrows times the distance between the two plates. Deposited evenly over the land, one inch of water is equivalent to half a gallon per square foot of ground. Thus, when half a gallon has been lost from the centre chamber of the infiltrometer the water made available is equivalent to 1 in. to one square foot of land. If the total area served is 3 sq. ft., then the water made available is equivalent to $\frac{1}{3}$ in. per acre.

With this method of irrigation, not all the surface of the land is being soaked, but below the surface

water has moved laterally and has soaked the land in an irregular pattern with the deepest penetration occurring immediately under the furrow. The water may or may not have moved across from one furrow to the next but this is usually the case.

When using the infiltrometer all three chambers are rapidly filled to the level in which the water will normally flow in the furrow. When this has been achieved a constant head, automatic feed, recorder is set in motion. By using this device to meter the water needed to provide a constant head, data is obtained of the time of contact needed for the furrow to absorb varying amounts of water.

Length of Run Tests

Having obtained details of intake rates, actual field tests must be carried out to determine how far the irrigating stream will run on varying grades in relation to time factors selected by plotting the intake curves. Depending largely on the soil type and the amount of available water, a decision must be made on the minimum and maximum amounts of water to be applied. For example, it may be desirable to apply a minimum of 3 in. of water with a maximum application of 4 in. at the upper end of the furrow. From graphs obtained of the distance the water travels in relation to time, it should be possible to determine the maximum time required for the water needed to flow into the furrow and how far this water will travel down the furrow. Using data obtained from the infiltration and length

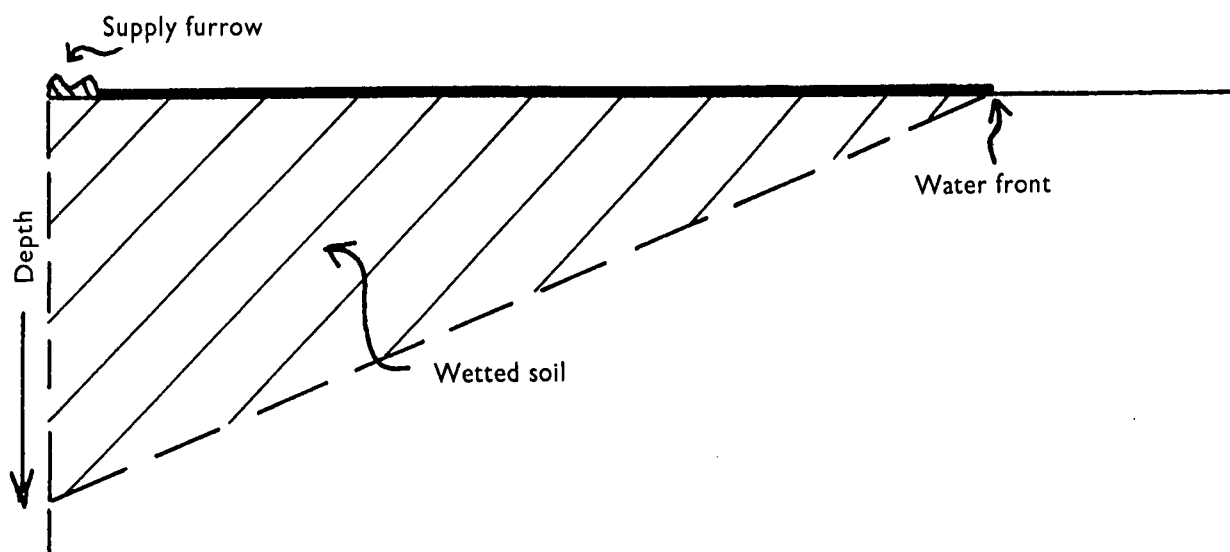


FIG. 4 Popular misconception of water absorption

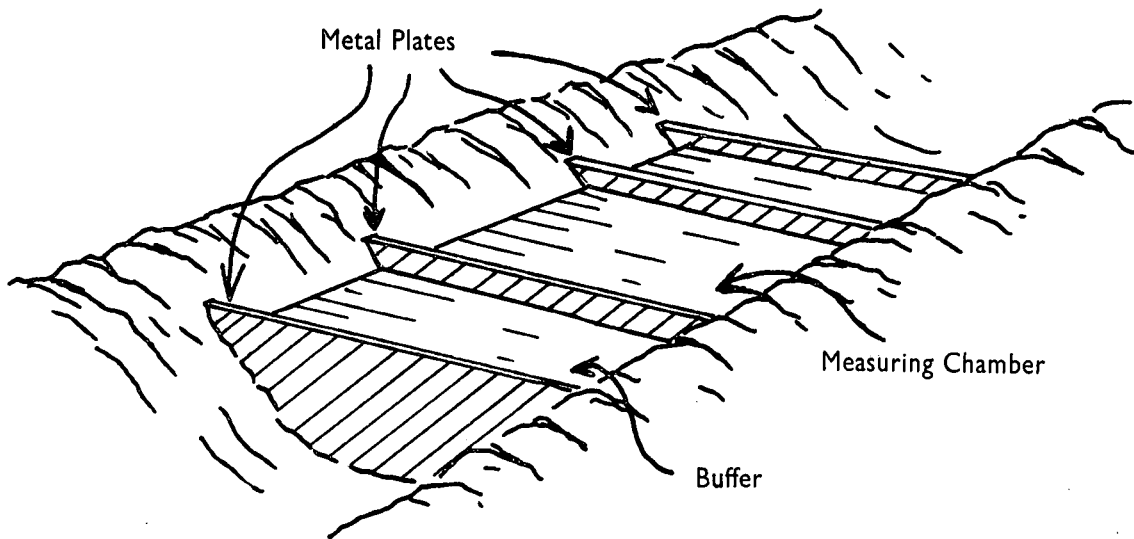
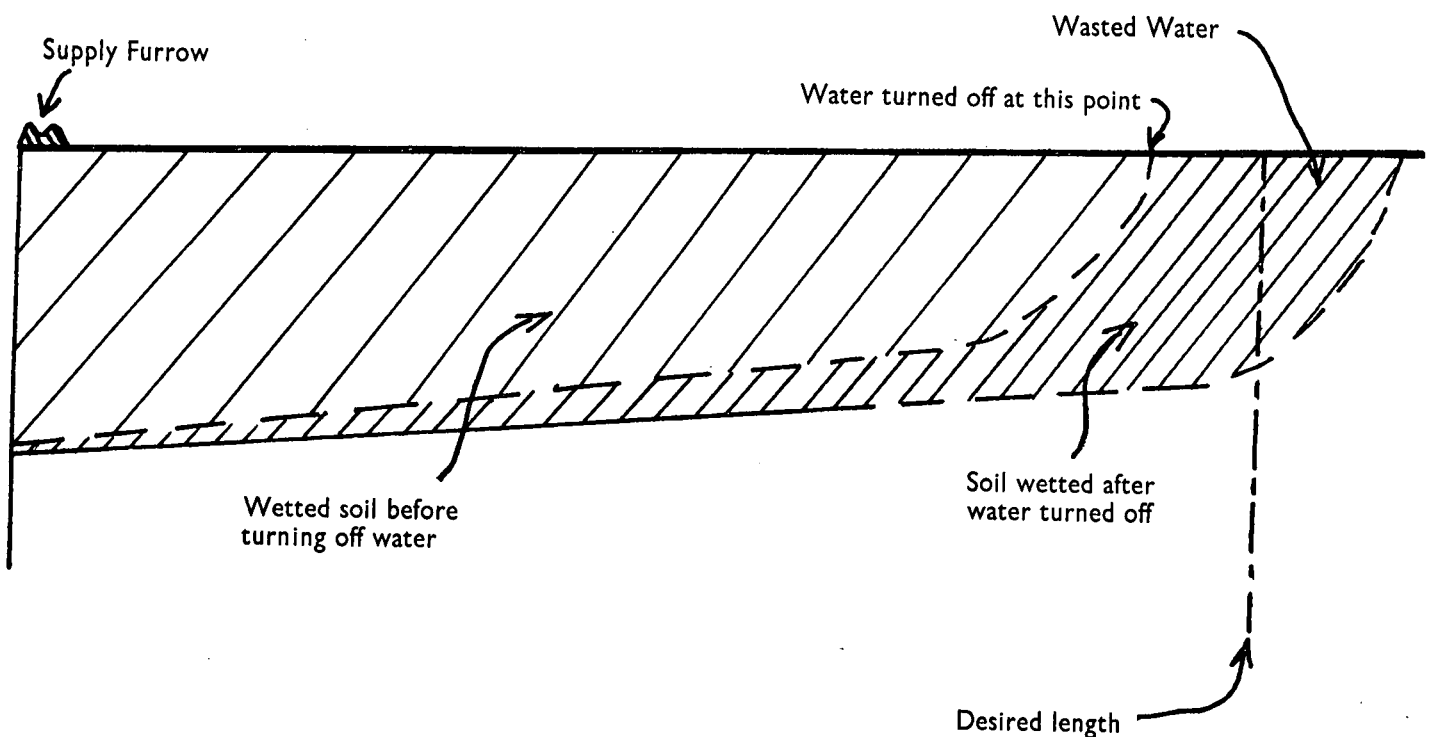


FIG. 5 Furrow Infiltrometer



of run tests it should then be feasible to decide on the optimum grade and length of furrow. The principles involved are illustrated at Fig. 6.

Summary

The relationship between time and the rate at which water is absorbed by soil, is not linear but parabolic. Due to this characteristic, furrow irrigation can be made reasonably efficient, provided soil conditions

and topography are suitable. Data needed for effective planning of furrow irrigation schemes are reliable measurements of soil intake rates and the results of actual field tests.

Reference

Criddle, W. D., Davis, S., Pair, C. H., Shockley, D. G. Methods of evaluating irrigation systems. Agriculture Handbook No. 82, S.C.S. U.S.D.A., 1956.

Mr. Thompson (in the chair): Figure 5 shows a diagram of an infiltrometer. Is the information obtained from the infiltrometer applied when drawing the furrow in the following diagram?

Mr. Turck: Yes, a trial run is made with the infiltrometer and then irrigation is controlled to give the desired application by shortening or lengthening furrows, or by changing the grades.

Mr. Leclezio: Southern Rhodesia has been using furrow irrigation for some time at Hippo Valley owing to the favourable slope of the land.

However, a section of 1,500 acres, about 10 per cent of the total, was placed under spray irrigation. Yields from furrow irrigation were far better than from spray irrigation.

However, you cannot control the maturation of the cane as well as can be done with spray irrigation.

Mr. Halse: Was there any difference between the soils under spray and under furrow? It seems rather sweeping to say that furrow is far better than spray irrigation.

Mr. Leclezio: There was some difference in the soils, but one plot of 80 acres under spray adjoined the furrow irrigated land and its yield was not as good.

Mr. Turck: I don't think the question here is whether furrow is better than spray irrigation. The point is that where the topography of the soil and the soil characteristics are suitable it is possible to use furrow irrigation fairly efficiently.

Mr. Gilfillan: How do you calculate the volume of water absorbed in the furrow infiltration test?

Mr. Turck: A four-gallon, or other size tin is filled with water and the level in the centre chamber of the furrow is kept constant by pouring water into it from the tin. The amount of water used at any time can be measured by the drop in level in the tin.