Agriculture Notes

Construction of an evaporation pan for irrigation scheduling

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Plants suck up water from the soil and lose the majority of this water to the air through their leaves. Ideally we would like to measure how much water is lost to the air so that irrigations can be accurately scheduled. Current technology is not capable of measuring how much total water flows through a plant. This amount however, largely depends on the evaporative demand of the air. This can be measured by the evaporation from an open surface of water. From evaporation readings irrigations can be timed so that the soil is at the right moisture level and irrigations run long enough to replace the water the plants have used.

There are many types of evaporation pans used by farmers. However, the universal pan is the United States Weather Bureau Class A pan evaporimeter (Figure 1). It is important to use the same dimensions as this universal pan, mainly because the effect of wind and temperature on evaporation will vary with the surface area and the depth of water in the pan. Evaporation and irrigation replacements cannot be compared between sites if non standard pans are used.

Construction

There are three parts to an evaporimeter (Figure 2). All parts can be made very cheaply with common materials. Alternatively a complete unit can be purchased at considerably greater cost. The following is a description of how to construct the three components of the evaporimeter.

Evaporation pan

The evaporation pan must be made to the standard specifications of an internal diameter of 1207 mm and height of 254 mm using 20 gauge galvanised iron. The standard material is galvanised iron as alternatives will have different thermal and reflectance properties, therefore altering the evaporation rate. It is best to have the pan made by either a galvanised tank manufacturer or an engineering firm. Before the pan is sited in the field it should be checked for leaks.

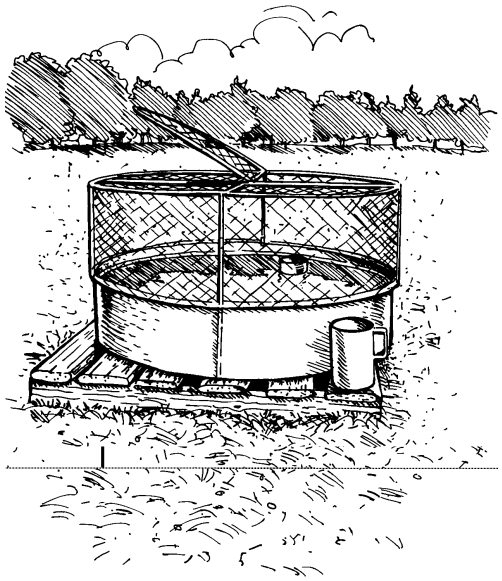


Figure 1. Evaporimeter

Fixed pointer

The fixed pointer that sits inside the pan can be made from standard irrigation fittings and a piece of stainless steel rod (Fig.3). There are three parts to the fixed pointer:

- the base, a Hardie 100 mm PVC flange
- the pointer support, a 230 mm long piece of 100 mm PVC pipe. Four equally spaced 9 mm holes 70 mm from the base are drilled to allow the water height around the fixed pointer to quickly adjust to the water height in the pan. A single 15 mm long 5 mm wide elongated hole is also drilled 70 mm from the base of the PVC pipe.
- the pointer, a 170 mm long piece of 5 mm stainless steel rod bent at a right angle 60 mm from one end. From the shorter end a thread is tapped for about 15 mm and a point is ground on the other end of the rod.

After fitting the PVC pipe into the flange, the stainless steel rod is inserted into the elongated hole with nuts located on the inside and outside of the PVC pipe. To initially set the stainless steel rod in the correct position, the fixed pointer is placed in the pan and the pan is filled with water to a depth of 190 mm. The rod is then slid up or down in the 5 mm elongated hole so that the point of the rod just breaks the surface of the water.

Measuring cylinder

To measure evaporation the pan must be refilled with a known volume of water. The surface area of the pan is 1.14 square metres, so for every mm of evaporation 1.14 litres of water must be added to the pan. A transparent plastic 2 litre measuring jug with vertical sides is an excellent measuring cylinder if it is scaled properly. It is important that the jug actually holds more water than 2 litres so the sides of the jug must extend past the 2 litre mark. The jug is filled with 2.28 litres of water and the water level marked. This can conveniently be done by weighing the jug and adding 2.28 kilograms of water. For most jugs this will just about overflow, which is perfect.

A jug of water filled to the marker will be equivalent to 2 mm of evaporation. To scale the jug when less than 2 mm of water is required to fill the pan, the distance from the top marker to the bottom of the jug is measured and divided by 20. The numbers 0 to 2.0 in increments of 0.1 are then written with a permanent marking pen from the top marker to the bottom of the jug. These numbers are equivalent to the same number of mm of evaporation from the pan.

Measurement

With evaporation the water level in the pan will fall. To measure the amount of evaporation, water is added to the pan with the measuring jug filled to the top mark. Water is added until the pointer just breaks the surface of the water. The PVC pipe supporting the pointer will help by reducing wave motion. It is important to keep track of the number of jugs used to refill the pan and the reading on the last jug when the pan water level is just broken by the pointer. The total amount of water added equals the amount of evaporation.

It is also essential to measure rainfall in conjunction with evaporation. Both measurements enable evaporation to be calculated on rainy days. After heavy rain the pan may have to be emptied to bring the water level down to the pointer. After rainfall on a hot summer's day, less water may have to be removed than actually fell as rain. For example, after a 25 mm rainfall there might only be 12 mm of water removed from the pan with the measuring jug to bring the water level back to the pointer. The difference between the rainfall (25 mm) and the water removed from the pan (12 mm) is the evaporation. In this example it is 13 mm.

If the rain does not fill the pan above the pointer, the rainfall must still be added onto the measured evaporation to give the actual evaporation. For example, if there was 7 mm of rainfall and 6 mm of water was added to the pan with the measuring jug then the evaporation would be 13 mm.

Evaporation measurements should be routinely done every day at 9.00 am and clearly recorded. If measurements are not done routinely then the volume of water in the pan will decrease and take less time to heat up during the day and cool at night. This will induce an error which will become greater as the volume of water in the pan decreases. Evaporation measurements are very simple and take less than 5 minutes.

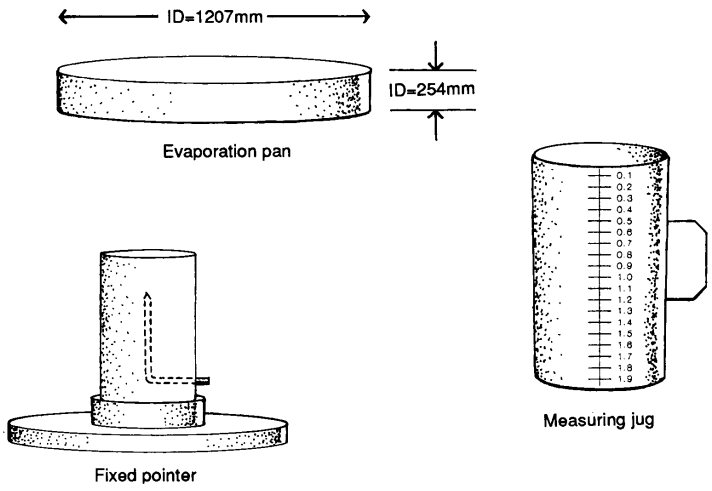


Figure 2 Components of the Class A pan evaporimiter

Siting

The pan should be placed on a flat wooden platform about 150 mm above the ground surface. A pallet is perfect. To avoid animals and birds interfering with the water in the pan we strongly advise covering the pan with chicken wire. This is not a USWB standard but is recommended for all agricultural situations. The error from covering the pan with bird wire will be small, much less than that introduced by animal interference.

To construct a simple chicken wire cage over the pan, bend a piece of 6 mm steel rod around the outside of the pan, welding the ends together to form a hoop.

Chicken wire is then loosely tied to the perimeter of the hoop. This cage can then be slipped over the pan.

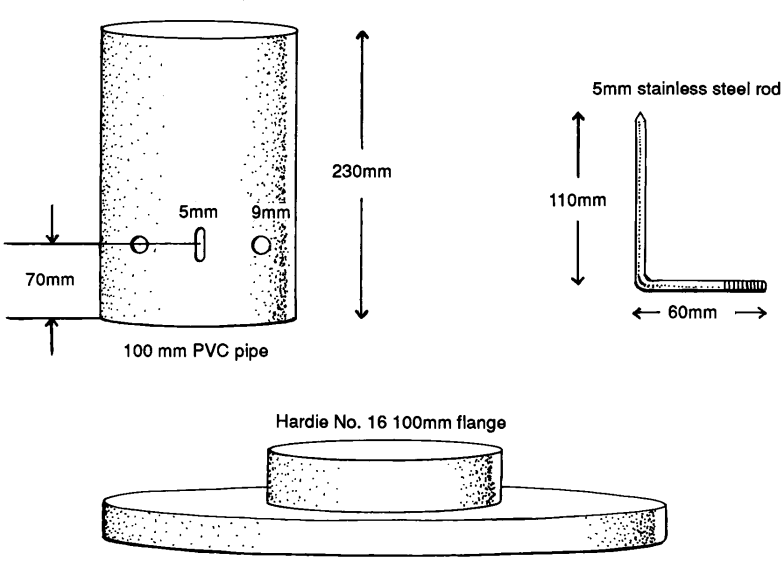
The area around the pan must be grassed and free from weeds, bushes and trees so that no shading can occur. The grass around the pan must be mown regularly and kept green. A nearby water supply is advised for refilling the pan and watering the grass around the pan.

Maintenance

The pan should be cleaned at least once a year. After cleaning and every month an algaecide should be added at the same rate as for swimming pools. If an algaecide is not added then the pan should be emptied and cleaned monthly.

If the maintenance or siting of the pan or the construction of the pan is not standard, then there will be a different relationship between evaporation and plant water use, but this difference is not critical if the differences are small and consistent. Variations from month to month like algae growth, unmown grass or reading at very irregular intervals are far worse than a consistent difference. For example we suggest that if the grass cannot be kept green and mown then the area around the pan should be kept bare with a herbicide.

It should be recognised here that non-standard evaporation pans can still be very useful for irrigation scheduling. They must, however, be evaluated on their own. Published irrigation replacement factors will be less accurate than for a standard evaporation pan. We recommend that if a non standard evaporation pan is used for irrigation scheduling then soil moisture and plant performance must be monitored to determine appropriate irrigation replacements from evaporation.



Components of the fixed points