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## Introduction

<b>Purpose of this document</b>	This document provides a review of mechanical water meter and present indirect methods to estimate water use in irrigation.
<b>Measuring irrigation water use</b>	Knowing how much water an irrigation system uses is an important precursor to effective irrigation management, and is vital to address the recommended indicators (e.g. water application efficiency)(see paper ...) in a meaningful way. Water use can be defined via direct measurements (e.g. water meter) or indirect measurements (e.g. energy used by a pumping plant, timing and estimating flow rate).
<b>Water meter</b>	It exists many different types of water meters and each of them is based on a specific technology. There are two categories of meter available – mechanical and non-mechanical. Mechanical meters include propeller, paddlewheel and turbine meters. Non-mechanical meters include ultrasonic and electromagnetic meters.

## Propeller meter

<b>Cost</b>	Prices range from about \$200 for a small one to over \$1,000 for a large size.
<b>Description</b>	The main parts of the flow meter consist of a propeller (A) mounted in a short section of pipe and geared to a revolution counter (B) which records the rate of flow and the cumulative total (fig. 1).
<b>Principle of operation</b>	The flowing water causes the propeller to rotate and each rotation is recorded in the revolution counter. A rotation corresponds to a specific volume of water according to the size (diameter) of the pipe.

<b>Remarks &amp; Recommendations</b>	
Since the flow meter works on the principle of a given rate of flow through a fixed area of pipe, the pipe must be flowing full for accurate results.	
Propeller meters need to be installed in straight sections of pipeline. Install the flow meter in the pipe at about eight pipe diameters away from any bends, elbows, or turbulence-causing fittings on the upstream side (refer to manufacturer's recommendations)	
Select the proper size of flow meter for the anticipated rate of flow. Meter sizes are generally classified by the diameter of the pipe in which they are mounted.	
Propeller meters require very little maintenance and are usually accurate to within two percent.	
You can install flow meters permanently in a pipeline (fig. 2) or make them portable with canvas or plastic hoses to clamp over a well stub to measure flow (fig. 3).	
Rates of flow such as liters per second (or gallons per minute) are then obtained by simply noting the volume of water on the dial for any given length of time as measured by a watch.	
Monitoring the performance of an irrigation system makes it possible to identify changes in flow rate during the season (measured at the same pressure). This change may indicate problems such as clogging of emitters or filters, leaks in the system, or problems with the pump or well.	

<b>Advantages(+)/ Disadvantages(-)</b>	
+	Accurate
-	Expensive

<b>Pictures</b>	
Fig.1 Propeller meter for use in pipes	Fig.2 Flow meter permanently installed
	Fig.3 Portable meter installation

### Energy use by a pumping plant

<b>Description</b>	For any pumped system, an alternative to measuring flow using a water meter is to relate the quantity of water pumped to the units of electricity used. This method requires volume of water used to be measured by a water meter and noting the electricity used for a given length of time. Volumetric water use can then be directly calculated from units of electricity used. Flow rates can also be calculated by dividing the volumes of water used by the run time of the system. An hour electricity meter related to the pump is necessary to apply this method.
<b>Cost</b>	The only cost arises from the need to rent a portable water meter in order to relate the volume of water pumped to the units of electricity used.
<b>Disadvantage</b>	Taking into account electricity use to calculate water use is accurate only if the operating conditions of the pump or irrigation system do not change significantly.

## Catch can method

<b>Description</b>	<p>Catch can tests are commonly used in drip and micro-sprinkler irrigation to measure the water flow at specific place of the irrigation system and then to estimate the volume of water use on the entire system when running.</p> <p>For drip systems, place the containers under each emitter along the lateral. Run the irrigation for a set period of time (half an hour is normally enough) and collect the water in the catch cans. The volume of water in each container is measured with a measuring cylinder and converted into an hourly discharge rate.</p> <p>Do the same for micro-sprinkler in placing the head of the micro-sprinkler into the measuring cylinder and catch the entire discharge.</p>
<b>Cost</b>	Inexpensive
<b>Example</b>	<p>Assuming the drip irrigation system was running for 30mn and 1500ml (1,5L) was measured in the can, thus:</p> <p>The flow rate is equal to <math>1,5 \text{ L} \times 2 = 3 \text{ L}</math> per hour.</p> <p>The volume of water use on the entire system during 1 hour is equal to the flow rate multiply by the number of emitter (dripper).</p>
<b>Remarks</b>	<ul style="list-style-type: none"> <li>- This system can be used to calculate the distribution uniformity of the system.</li> <li>- Can also be used to identify changes in performance due to poor maintenance or age of the system.</li> </ul>

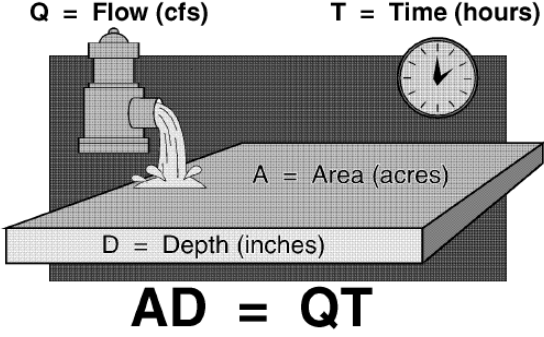
## Bucket method

<b>Description</b>	Measuring the period of time required to fill a bucket (or container) of a known volume can be used to measure small rates of flow such as from individual tubes in small surface flooding irrigation, sprinkler nozzles.
<b>Cost</b>	Inexpensive. Depend on the price of the bucket and the stop watch.
<b>Recommendation</b>	It is recommended that the measurement be repeated at least three and preferably five times to arrive at a reliable rate of flow per unit of time.

## Water applied by surface irrigation

<b>Description</b>	During flood/furrow irrigation, irrigators should not be content merely to get the water to the end of the furrows, but should also consider how much water is applied and how it is distributed. Producers should think about surface irrigation in terms of depth of water applied to the field. The simple relationship $AD=QT$ can be used to determine the amount of water applied by surface irrigation systems (fig. 1).
<b>Remark</b>	The rate of flow has to be known. It can be estimate via the "Bucket method".
<b>Cost</b>	Inexpensive.

<b>Example</b>	<p>1 cubic foot per second (cfs) applied for 2 hours will result in 2 inches of water applied to 1 acre.</p> <p>Note: To convert the volume in <math>m^3</math>, thus:          The depth D must be in mm          The area A must be in <math>m^2</math>          The flow Q must be in <math>m^3</math> per unit of time          The time T must be in the same unit of time than for the flow</p>
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<b>Picture</b>	
<p><b>Q = Flow (cfs)      T = Time (hours)</b></p>  <p><b>AD = QT</b></p>	
<p>Fig.1 Simple method for determining amount of water applied by surface irrigation</p>	

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