# Principles of Irrigation Scheduling

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The basic issues to be considered and monitored to develop and manage an irrigation schedule are outlined below

**• Positioning monitoring sites**

Monitoring sites need to be selected carefully in order to allow for soil and crop variations. Positioning monitoring sites within the average soil types will reduce the risk of the better soils being under-watered and the worse soils being over-watered. Ideally, a soil survey at the time of the irrigation development will provide you with the information on soil variations. The information collected from the survey will allow you to plan the irrigation system according to soil variations, and position monitoring sites in representative locations.

Positioning monitoring sites in relation to the crop and irrigation system are also important considerations. Care should be taken to ensure that the site will record both representative water use of the plant(s) and wetting from the irrigation system. There are a number of factors that need to be taken into account such as plant spacing, crop type and soil type.

Care should be taken when installing the sensors, to ensure that soil and crop disturbance while monitoring sites is minimised. Ensure that you do not compact the soil near the site, or destroy the plants (annual crops generally) by stepping on them while installing the sensors. Considerable site disturbance will effect the representativeness of the data you are collecting.

**Depth at which sensors are installed**

The number of sensors, and depth at which they are installed is an important issue to be considered when establishing a monitoring site. This will depend on the sensors being used, as some systems utilise individual sensors buried at certain depths while other systems operate on a single sensor lowered down access tubes, which can measure multiple depths.

The issue for consideration is to be able to differentiate between water use and drainage. If only one sensor is buried, you will be able to monitor wetting and drying patterns, however it is difficult to distinguish whether the drying is caused by water use, by drainage or a combination of both. That is why it is advisable to measure at least two depths, if not three within the profile, (preferably one at the top, one near the middle, and one below the root zone), thus ensuring you are able to differentiate between water use and drainage.

**• Taking readings**

Depending on the system that you are using, (manual versus automatic), readings should be taken on a regular basis, so that you are able to interpret wetting and drying patterns to assist with data interpretation. With manual systems, it is ideal to ensure data is collected before irrigations, to see how dry the soil is, after irrigations, to see how effective the irrigation was, and ideally between the irrigation cycle to monitor if there was any excess slow drainage of water below the roots or to measure the depth and rate of water extraction.

Another consideration is to ensure that you do not compact the soil or destroy the plants that you are monitoring when you take the readings. This is of more concern with annual crops, where you may need to walk out into the crop. Continual monitoring at such a site can lead to soil compaction and potentially unrepresentative crop growth. This issue is not of major concern with automatic logging systems, as data is generally collected from a central logger away from the site or even at the PC in the office, if a telemetry system is used. Even though the data is being continually recorded, it is wise to view the data at least a couple of times a week so that you can make immediate management decisions, rather than collecting historical data.

**• Establishing the depth of the root zone**

To calculate the frequency and duration of irrigations, the depth of the active root zone of the crop being monitored must be determined. The volume of soil that the roots of the plants are occupying will effect the volume of water that is available to the plants and the volume of water needed to be applied to replenish the profile.

Quantifying the depth of the root zone can be achieved in a number of ways. If a soil survey has been conducted, root zones can be estimated if a crop has not been planted, or visually inspected if plants are growing. Data collected can provide information on the depth of water extraction by the plants. As mentioned above, if individual sensors are being used, care should be taken to ensure that at least one sensor is positioned within the root zone of the crop and one below the root zone.

**• Establishing the full point**

In simple terms, the full point can be defined as the wettest the soil within the root zone of the crop can be before there is through drainage. This will depend on the soil texture, as clays, loamy clays and clay loam have a greater water holding capacity than lighter textured soil such as sands and sandy loam. The depth of the root zone will also have bearing on the full point of the site, as obviously a deep rooted crop on a heavy textured soil will require more water less frequently, and a shallow rooted crop on a light textured soil will require less water more frequently.

By measuring soil moisture before and after an irrigation, (generally six to twenty four hours after, depending on soil types), you are able to quantify the depth to which the irrigation event wetted. The data collected between irrigations should provide information on the depth of the active root zone. By comparing the depth of the irrigation compared with the depth of the root zone, you are able to determine whether sufficient or excess water has been applied to adequately replenish the root zone of the crop to the full point. Excess water moving below the root zone (above full point), will result in wasted water, increased pumping costs, leached fertlisers (lighter soil generally), and in heavier soils, potential water-logging. Insufficient water applications, that do not replenish soil moisture levels to the full point can result in more frequent irrigations than what is required or a gradual depletion of the soil moisture within the root zone of the crop.

**• Establishing refill point**

The refill point can be defined as being the driest a soil can be for a given soil and crop type before there is a decline in water use resulting in inadequate reserves of water for optimum growth to be maintained. The moisture level at which the refill point is set will depend on a number of factors including soil type, crop type and management strategies. There is a direct relationship between crop water use and yield, therefore if a crop is unable to use water to its full potential, yield and quality potentials can be reduced especially if the period of low moisture conditions corresponds with a moisture-sensitive growth stage.

As soil moisture levels fall below the true refill point, two physiological processes can be measured using soil moisture sensors. Firstly, crop water use declines (if weather conditions have remained constant), and the depth of water extraction increases as the readily available water within the active root zone falls below a critical level, and the crop searches deeper into the profile for moisture.

The refill points for specific crops may be adjusted during various growth stages of crop development in order to modify or promote various plant characteristics, as discussed earlier in this paper.

**• Effectiveness of irrigation or rainfall events**

For accurate irrigation timing, it is critical to be able to identify the effectiveness of irrigation and rainfall events. This will have bearing on when and how much water needs to be applied. The difference between actual and effective irrigation or rainfall events must be identified when developing and managing an irrigation programme. The “actual” irrigation or rain event is the volume of water either measured in a rain gauge or flow meter, whereas the “effective” amount is that which has infiltrated into the root zone of the crop and is available to the plant.

The water that has either run-off, evaporated or drained below the root zone of the crop is not available to the plants. Without objective soil moisture data, it is very difficult to quantify the volume of water available to the plants, which has either been applied through irrigation or has fallen as rain.

**• Plant water use**

Plant water use will vary according to growth stages, prevailing weather conditions and soil moisture status. The rate of soil water depletion by the crop will affect the frequency of irrigation events. Through soil water monitoring, the rate of soil water depletion can be measured and predictions on when and how much water to be applied can be calculated.

Plant water usage is a good indicator of the soil moisture status. As soil moisture within the root zone falls below the refill point, plant daily water use generally declines (when weather conditions have not changed). A decline in water use, caused by inadequate water reserves, generally occurs before any physical symptoms of water stress are observed. The ability to identify the critical lower limits of soil moisture (refill point) within the root zone is invaluable in maintaining optimum soil moisture conditions for maximum growth potential. Once the crop displays visible symptoms of water stress, water use rates will have declined, and if this water stress occurs at periods of high moisture demand, significant reductions in potential yield and quality may result.

The ability to establish, monitor and manage the above parameters is critical in developing and managing an irrigation programme. Evaporation data can be used, however with this technique, you are measuring the rate of evaporation from a surface of water, multiplying this value by a crop factor, and then applying this value as crop water use to determine when and how much water needs to be applied. This management tool does not take into account such issues as:

• Soil water holding capacity

• Effectiveness of irrigation or rain events

• Depth of water infiltration

• Depth of plant water extraction

• Effects of plant health on water use

• And others.

In cases where soils are compacted, where there are problems with surface sealing or where there are clay pans which restricts the movement of water into and through the soil profile, soil moisture monitoring should be implemented; not only to identify, but to implement management practices to rectify these problems.

The three main driving variables on which irrigation management decisions are based upon are:

• How much water the root zone of the crop can hold

• How much water infiltrates into the soil

• How much water is the crop using?

The basis of irrigation scheduling is using objective measurements in conjunction with plant inspections to eliminate the guesswork involved in estimating how wet or dry the soil is in order to decide when and how much water to apply. Irrigation management varies from property to property and field to field. Data collected on one property, or even field, is not relevant to another, therefore farmers must develop and manage their own scheduling programmes based on their soil and crop types.

Soil water management can make a dramatic difference to the profitability and sustainability of an irrigation enterprise. Making informed irrigation decisions based on accurate data can maximise the income per unit of water and capital. New irrigation delivery systems provide growers with the ability to apply the correct volumes of water to the correct areas in order to increase potential returns per unit of water applied to a crop.

Water management is the “missing link” with many irrigation enterprises. Unfortunately, too many growers are investing considerable capital and resources into areas of management such as pruning, soil preparation, sap and tissue analysis, fertliser application and improved irrigation systems. For example, incorrect timing of irrigations can promote excessive vegetative growth that needs pruning. Capital invested in sap, tissue or soil analysis, and consequently fertliser applications, can be literally washed down the drain through over-watering. Investment in upgrading or developing new irrigation systems, such as drip, mini jets or mini sprays can be negated by not understanding how to manage these water delivery systems. I have seen cases where growers have upgraded their flood irrigation systems to mini jets, and have been using the new system as an easier way to flood irrigate, by running the new sprinklers for up to 16 hours, when 6 hours would have been sufficient to wet the root zone. Crop health and vigour, in these cases have declined as a result of poor water management causing a perched water table within the root zone of the trees. Poor water management can negate the resources committed to these management issues.

Water has to be considered as a management input, just as fertilisers and sprays are. Irrespective of how well all other farming practices are managed, without soil or water, there is no crop to manage.

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