Irrigation system design

Efficient irrigation systems form the basis of supplying sufficient and equal amounts of water to all crops and plants. There is a variety of irrigation systems available, each with a correct application that will deliver the best results in the particular circumstances.

Farmers should aim to achieve the best possible water use efficiency for their systems. Less efficient systems bring about reduced crop yields and waste water, energy, fertilisers and labour. Therefore it is important to use a properly designed irrigation system.

Overhead irrigation systems

With sprinkler irrigation systems, water is sprayed into the air and falls to the ground in a distinctive distribution pattern which depends on the pressure that it is operating at.

Changes to the distribution pattern, with a resulting loss of efficiency, will result from nozzle wear, incorrect operating pressure, leaks in the system, incorrect placement of sprinklers and numerous other factors. Changes in working pressure will change the way that water is distributed. Higher or lower operating pressure will alter the pattern of distribution both through the air and the way water sinks into the soil.

It is essential to know what the correct operating pressure is for emitters used in the field to attain efficient irrigation. In the case of a sprinkler irrigation system, the pressure can be measured at the emitter. The operating pressure of an irrigation system can be measured and controlled at the hydrant valve.

Pressure gauges are vitally important, because if the pressure is too low, the water jet does not break up easily and most water falls in a donut, some distance from the sprinkler. Excessively high pressures will cause the jet of water to break up too much. A fine mist will form, which can easily be driven away by wind. Most water will also fall close to the sprinkler.

The correct pressure will produce a distribution pattern which will allow for the best possible final overlapped distribution of water between a series of sprinklers spaced at the selected distance apart.

Drip and micro-irrigation systems

In drip and micro-irrigation systems, the emitter often supplies only a single plant. The amount of water that the plant needs can be delivered at any point in the root zone. The plant will then develop a root system that draws water from that point where it is normally available.

The distribution of water in the soil below a dripper will vary significantly, depending on soil type and structure. The even distribution of irrigation water is very important. Uneven distribution will lead to uneven plant growth rates, which will cause a loss in production. Field tests and system evaluations can help a farmer to improve maintenance and management, thereby increasing efficiency and production.

System maintenance

Every irrigation system requires regular maintenance. Poor maintenance will cause the performance of an irrigation system to deteriorate. Water distribution and irrigation efficiency will suffer.

Regular checking of sprinkler nozzles for wear and malfunctioning is vital. The cause could be as simple as a piece of dirt that is stuck in the nozzle or it could be a sprinkler that needs to be replaced. If a nozzle is worn, more water will escape at normal operating pressures.
In a drip irrigation system it is not essential to wet the entire soil surface uniformly. It is, however, crucial that each emitter should deliver the same amount of water. Poor emitter application efficiency will seriously impact on crop production.

Mini-sprinklers and garden sprayers
Equipment used to irrigate small areas in community gardens, were developed with the urban garden in mind. Community gardens are increasingly being recognised as an important activity in rural communities. Irrigation plots are small and it is often difficult to plan appropriate systems by using conventional irrigation technology. Garden systems make use of mini-sprinklers and garden sprayers to distribute water.

Garden sprayers operate at low pressure (between 150 and 200kPa), typically covering a small area – seldom exceeding a radius of 6m. Application rates are often very high and if the sprayer is left in one position for too long, water will run off and not penetrate the soil.

The distribution pattern of orifice sprayers is irregular. More water is usually sprayed to one side. This makes it essential to always point the sprayer in the same direction when using it in the field. The system design will attempt to overlap the natural skewed distribution pattern to achieve an even distribution. If sprayers are not properly aligned, the application rate will be erratic and irrigation efficiency reduced.

Sprayers normally connect to a supply line by means of a garden hose attached to a riser valve. Orifice sprayers are closely spaced, with normal in-field spacing of between 5 and 6m. A single sprayer can be used to irrigate an area of up to 600m², or a number of garden beds.

Irrigation plots are normally designed so that the sprayer can be placed between beds and sufficient overlap still takes place in the centre of the bed. Good vegetable production is possible in small community garden plots that use garden sprayers to irrigate.

Use of grey water
The ideal should be to reuse water where possible for purposes other than drinking water, for example in toilets or for supplementary irrigation in gardens.

Water from the bath, basin, shower and laundry washing that is not soiled with human excreta can be collected through a filter into a small holding tank. From there it is pumped to irrigate a garden plot. The grey water can also be collected in a bucket and dispersed manually. Water from the kitchen is not used as it contains fat, grease and food particles.

Long-term use of certain washing powders with high phosphate content will have a negative effect on the soil. Grey water cannot be applied through drip and micro-irrigation systems because it contains particles that will cause clogging of the emitters.

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Care must be taken that the standpipe of the sprinkler stands upright, otherwise the distribution pattern of the sprinkler will be affected negatively. The sprinklers must also be aligned properly, otherwise parts of the field will be over-irrigated and other parts will receive insufficient water.

In all cases, the distribution pattern of water around the sprinkler will change. It will also have a negative impact on the performance of the other sprinklers in the system as well as on the pump performance. Energy costs will increase; irrigation efficiency will drop and crop production will decrease.

It is important to regularly replace worn nozzles with new ones of the correct size and type, or otherwise sprinkler application rates and distribution patterns will also change. Each type of irrigation system will naturally have a list of maintenance operations that should be carried out on a routine basis.

Every irrigation farmer should have an operations manual for his system that details maintenance tasks, and a toolbox containing all the tools needed to perform routine maintenance tasks. It is also important that the farmer keeps a contact list of people for advice or assistance with specific problems.