Practical Consideration For Promoting Drip Irrigation

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Overview

Drip is perhaps the most heavily promoted form of irrigation, particularly by those who do not have to pay for it, operate it, or maintain it, such as the SIDA agriculturist who, for a project in Tajikistan, insisted on it but did not know what an emitter was, and how easily they can become plugged. Similarly, many of the PRTs have suggested it for their provinces without the in-depth evaluation as to if it really was the most suitable form of irrigation and could be economically sustainable for the individual farmer. As usual the promotion is almost solely based on the potential for drip irrigation to save water. This may be a concern of the host in the government, but most likely not the primary concern of the producers. The purpose of this write-up is to provide the PRT and other interested individuals a more in-depth understanding of drip irrigation and some of the practicalities that need to go into whether it is the most suitable irrigation technique for a given area.

Drip irrigation is usually the most expensive, sensitive, and complex to manage, with high reoccurring and replacement costs. The heavy promotion of drip irrigation is mostly due to its potential to reduce water use. However, "***its effectiveness in saving water can only be realized, if and only if, the minimum application by alternative means, such as sprinkler and surface, is greater that the crop water needs***". Thus it can become important in incomplete canopy crops such as fresh vegetables, but not necessarily process tomatoes for which the vines tend to fill the canopy. The effectiveness of drip in saving water is based on reducing the soil evaporation component of the evapotranspiration water loss, while not reducing the plant's transpiration. With a full canopy crop that already greatly reduces the soil evaporation losses and the vast majority of water loss is by transpiration, sprinkler systems can be nearly as efficient as drip systems in meeting the crop water requirements. It must also be recognized that evaporation losses from water on the leaves either from rainfall or sprinkler irrigations are a one-for-one substitute for transpiration losses as the latent heat of evaporation energy is the same.

Primary Use

Thus the main use of drip irrigation for reducing water use comes when water is either very expensive or very scarce. This water scarcity or expense has to be at the individual farm level and not the overall system level. An overall national water scarcity and the national need to reduce water is a very legitimate concern for the MoWR, but is of no concern to the individual farmer, neither is the concern for a neighbor water scarcity just down the field canal. Drip irrigation was first developed in Israel where water was scarce and used mostly for vegetable and fruit crops, and not wheat, maize or other full canopy crops. In the USA some of the initial use of drip irrigation was outside San Diego where the irrigation water supply was treated municipal water which some 15 years ago was valued at $700 /ac.ft. ($0.57/m^3). There drip was used for vegetables such as pickling cucumbers. Currently, an

[1] The ideas contained in this paper are strictly the author who is solely responsible for the content. Some of these ideas may and probably are in contradiction to other Inma and USAID opinions. In such cases it hope they rational behind the opinions will be appreciated and lead to more comprehensive discussions and better overall programs.

extensive amount of buried drip is being installed in Eastern Colorado in response to declining well yields of the Ogallala aquifer falling below the critical ET level for a full circle center pivot. Thus the center pivots are not able to keep up with ET rates, and the operator's choice is either windshield wipe the Center Pivot, forfeiting half the land, or use drip and irrigate more area. This time the crop is maize but the actual water saving needs some careful evaluations, as considerable amounts could be leaching down from the buried drip line particularly early in the season when roots have not fully developed and reached the tape. In Iraq a water scarcity at the individual farm level is rare particularly in the areas served by irrigation canals. With surface water provided free of charge to the farmers the cost of water does not factor into the drip irrigation equation, and the administrative overhead cost for a true volumetric measurement charge to smallholders is prohibitive. At present drip irrigation in Iraq is mostly used in the small independent irrigation systems pumping water from semi-shallow wells to irrigate a few dorum of vegetables. Here the depth to the water table and yield of the wells restricts the amount of water available and shifts the balance in favor of drip. Most of this is in Southern Iraq near Basra. Suitable drip equipment is actually locally manufactured in Basra by numerous small shops.

Secondary Uses

Other uses of drip are for irrigating tree crops in terrain too rugged for sprinkler or surface system. The example is avocados in California being irrigated with micro-sprinklers in the hilly terrain between San Diego and Los Angeles. Drip can also be used to reduce humidity sensitive diseases such as mildew in grapes. In this case the drip lines and emitters are usually suspended on the wires supporting the vines and dripping between individual plants. This effectively keeps the drip lines out of the way when cultivating the grapes. It would to a lesser degree apply to late blight control of tomatoes.

Drip does offer some fringe benefits such as increased field access for multiple frequent picks of vegetable such as pickling cucumbers that have to be picked every 2 or 3 days. Once they shifted to drip irrigation because of water costs they were no longer forced to wait several days for the surface to dry after typical furrow irrigations. The increased access effectively off-set the extra cost of the drip system.

What is drip Irrigation?

Emitters: Drip irrigation is any of several forms of micro irrigation applicators that place water as close as possible to the plant root, and avoid applying water to areas were plants are not growing. This is done by using small plastic tubing with individual emitters embedded in the tube at approximately the plant spacing or the perhaps connected by capillary tubing to reach individual emitters as in a flower garden. It also includes micro-sprinklers which discharge a small amount of water up to 10 feet from the source. The key to drip systems is the emitters. They are considerably more complex than a simple hole in the tubing, that would result in water spouting out like a leaky hose with different rates depending on how the pressure changes down the line, either decreasing with increased height or loss of water, or possible increasing if going downhill (Fig. 1). Therefore, emitters are fundamentally pressure compensators designed to assure uniform distribution of water along the entire drip line. This is normally done with what is referred to as a torturous track in which the water enters the emitter via a small hole or screen from the main tape and then works its way through many snake like turns while friction loss continuously reduces the pressure until the water emerges as steady drips instead of spouts (Fig. 2). With alternative types of drip tape water enters a capillary channel about 20 cm prior to the slit through which the water eventually exits the tape. These emitters typically operate at 2 l/hr. Emitters can also be as simple as a piece of capillary tube with a twist for pressure control as the sample from Zambia (Fig. 3). The indigenous emitters in Iraq are similar to this being comprised on a small curl of capillarity tubing, perhaps containing 3 or 4 complete loops.

Fig. 1. Water spouting from a simple hole in a hose with no means for pressure compensation.

Fig. 2. Behind the clearly visible hole is a torturous track pressure compensator in a typical drip emitter.

Since the water has to pass through these small holes and twists and turns drip emitters are susceptible to plugging by particulate matter in the water, algae and fungi in the water or soil were the water exits the emitter, and mineral crusts formed by dissolved Ca or Mg in the water converting to insoluble Ca and Mg oxides upon exposure to the air as it emerges from the emitter. This all requires an extensive sand filtering system to remove all particulate matter, which is definitely a problem with the turbid surface irrigation water in Iraq (Fig. 4). It also requires occasional preemptive flushing of the system with Clorox to kill the algae and fungus before the build-up is enough to plug the emitters and also with sulfuric acid to dissolve and move Ca and Mg crust away from the emitters before they plug. This is usually done every couple months during the season. This has to be preemptive because if deferred until the emitters plug, the treatment is rendered ineffective. In Iraq like most developing countries there is a major tendency to emphasis deferred maintenance over preventive maintenance.

Fig. 3. Alternative emitter manufactured in Zambia with the pressure controlled by simply tightening the loop.

Fig. 4. Bank of sand filters for filtering water for commercial large scale drip system, even when using well water with limited suspended particulate material.

Management concerns: Other areas where drip irrigation can have problems that require some continuous monitoring is rodents chewing the lines to get to the water, particularly buried drip which is hard to see. While surface systems may increase field access, cultivation around the plant is hindered by the extra time and effort it takes to maneuver around the drip tape with reasonable opportunity for cutting the tape with a hoe or other cultivation implement (Fig. 5&6). This is an indirect but very real extra cost for drip systems. Finally, a very personal incident from my back yard drip system is my neighbor's roommate discarded a cigarette butt by flicking it at my fence. It actually went through a crack between pickets, landed on the drip line, and melted a hole in it (Fig. 7). This happened while I was on vacation so for up to 6 one hour drip cycles water flowed freely through a 6 mm hole in the drip line. Observing the number of people smoking in Iraq and working in the fields this could be a real problem. As a cost saving drip tape is fairly thin and thus easy to cut, burn or melt through.

Fig. 5. Drip demonstration in Zambia showing the complexity of drip lines that need to be weeded around.

Fig. 6. Drip demonstration in Tajikistan that also will require extra time and effort to work around, adding an indirect cost to drip irrigation.

Fig. 7. Cigarette accidentally discarded against my home drip line melted a 6 mm hole in the line.

Chemigation: Drip systems can easily be used for chemigation including N fertilizers and systemic plant protection chemicals, both insecticide and fungicides. Subsurface drip systems can also be used to inject Phosphoric acid for fertilizer.

Service Life: Drip system, particularly surface systems, have more limited service life and need replacement more frequently than other systems particularly for surface drip systems subjected to the sun's ultra-violet light. In Iraq the locally manufactured material only lasted one season, while imported drip material lasted 2 year or more. Thus the $1000 /ha Netafilm estimated cost of a system has to depreciate in 2 years instead of the same $1000 depreciating over 10 years with center pivot.

Buried Drip: Buried drip systems can last up to 10 years, if they are well maintained. However, buried drip has to be buried deep enough to avoid any tillage implements that may be used to work the soil. That normally means approximately 50 cm below the surface. At this depth it might be difficult for the capillary front to reach the surface except for fairly heavy clay loam soils. If it cannot, then the first couple of irrigations have to be surface irrigations until the root are estimated to be within sufficient proximity of the drip tape to obtain the necessary water. Also, buried drip may not be as water use efficient as expected because despite the tutorial video on water movement showing a uniform movement up, down, and horizontally, for easy visibility in the video the water was injected into a dry soil. Under more typical field conditions the soil would start considerably moister and thus the influence of gravity would be more apparent and the circle of water movement would sag substantially (Fig. 8). However, this is a difficult type of soil water movement to quantitatively measure. Also, once installed, the field layout is precisely fixed and cannot be changed for the life of the drip system. Each tillage operation has to be done precisely beside the drip tape so as not to become entangled with the drip tape.

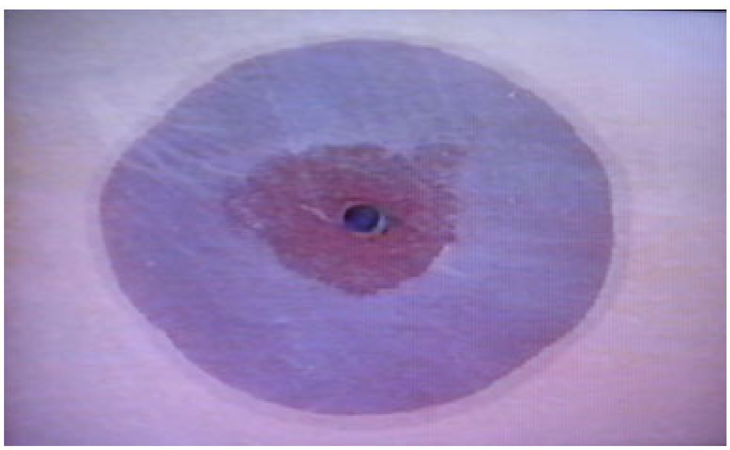

Fig. 8. Picture taken from video of capillary water movement from a simulated buried drip emitter. Video was made with dry soil, and thus most likely under more moist field conditions the circle would sag downward under additional gravity force.

Drip Layouts: Because of the limited amount of water individual drip tapes can convey, drip systems tend to be in smaller blocks and zones then surface or other types of irrigation. Typically sets would be no more than 3 ha and 6 zones consolidated into 1 block. The irrigation schedule would then be fixed at 4 hours on and rotated among the 6 zones in a block to allow 20 hours off. With the temperature and humidity in Iraq it might be difficult for this watering rate to keep up with the 11 mm daily ET and the system adjusted to 4 zones per block and irrigation 6 hour on and 18 hours off.

Recommendation: It would be greatly appreciated if those PRTs promoting drip irrigation could consider all the issue mentioned above before making a final decision if drip irrigation is really the most desirable type of irrigation for their area. If not please consider alternatives.