healthy soils case study

SUB-SURFACE DRIP IRRIGATION

Sub-surface Drip Irrigation: Improving soil (and water) management

A Narromine, Macquarie Valley, case study

The background

Large areas of red soils are used for irrigated cropping across cotton growing regions. These red soils have high infiltration rates and a lower water holding capacity than the grey clay soils that are also common in cotton regions. Surface crusting or sealing is a common problem with red soils, resulting in poor water infiltration following rainfall or surface irrigation.

Stewart Crawford farms near Narromine in the Macquarie Valley, NSW and has been one of the pioneers of sub-surface drip irrigation in broad acre crops. He has been using sub-surface drip irrigation to grow irrigated cotton and grain crops such as corn, sorghum and wheat for nine years.

The soils on his farm are sandy loam, drain freely and have a fragile surface structure. Stewart has undertaken significant work to improve the soil structure with minimum tillage and the application of gypsum/lime.

Why act?

Stewart believed too much water was being lost below the root zone as deep drainage with surface irrigation. He decided to investigate drip irrigation as a crop management system to reduce the amount of water lost as deep drainage. A critical aim was to increase yields with the judicious use of water. If yields could not be increased using drip then a drip system would never pay for itself. As there were very few drip irrigation systems in broad acre crops in Australia a decade ago, Stewart visited the USA on a study tour to look at drip irrigation systems as a means of reducing water losses on his farm.

The Solution

Stewart installed his first 50 hectares of sub-surface drip tape nine years ago and now has 175 hectares (432 acres) of sub-surface drip irrigation.

"The bottom line is that with sub-surface drip irrigation water use has halved, fertiliser use has reduced and yields have increased"

Stewart Crawford, who farms on Quondong, Narromine, is an Australian pioneer of sub-surface drip irrigation in broad acre crops

The drip irrigation provides greater control of water and nutrient application: rates can be changed daily to match weather conditions and crop growth needs. The irrigation water is pumped from a bore into a storage dam. This ensures a reliable water supply, should there be any problems with the bore.

Crop nutrition

One of the significant benefits of drip irrigation is crop nutrient management. Sub-surface drip irrigation enables nutrient application using fertigation techniques (nutrients applied in the irrigation water) at very precise rates on a daily or weekly basis.

Typically, Stewart applies most of the crops phosphorus needs at planting, with about 25 per cent of the crop's nitrogen fertiliser requirements. This is the cheapest way to apply phosphorus. The remainder of crop fertiliser needs are applied through the irrigation water. This includes about 75 per cent of the nitrogen, which is supplied from urea, as well as anything else such as potassium and boron that is needed.

Typical Fertiliser Rates

Cotton	160–220 units of nitrogen
Corn	280– 325 units of nitrogen
Sorghum	180 units of nitrogen

Drip requires more energy to pump the water and this must be factored into budgets.

Crop water use

The most challenging period with drip irrigation is wetting the soil prior to, or just after, planting. This can require up to two megalitres per hectare, depending on how dry the soil is. Pre-watering is very time consuming and is usually started three weeks before planting.

Stewart likes to keep a large area around the drip tape wet. This is good for peace of mind should there be a breakdown, as at least there are a few days of water stored in the soil profile. It also provides high yielding crops with plenty of wet soil to explore for moisture and helps to keep roots out of the drip tape.

Typical Crop Water Use Figures

Seed sorghum

2–6 megalitres per hectare, depending on yield expectations and rainfall.

Corn

9 megalitres per hectare (corn usually uses one megalitre per hectare more than cotton). The last two years averaged 15 tonnes per hectare.

Cotton

4.5– 8 megalitres per hectare, depending on rainfall and how much water is needed to pre-water the soil prior to planting. The average yield over the previous seven seasons was 11.2 per hectare (4.5 bales per acre). Stewart hasn't grown cotton for the past two years and, with the new high yielding varieties, yields will be higher in the future.

"A reliable water supply is a must for drip irrigation because of the initial large capital investment. The drip system needs to be growing a crop every year to pay back that initial investment quickly"

High-yielding crops produce plenty of organic matter, which improves soil structure and protects the soil surface

Soil health

Stewart believes the soil has improved with drip irrigation. One of the main benefits of the drip irrigation is that irrigation water is not run over the top of the soil surface, which helps the soil tilth and surface structure.

One of the consequences of no deep drainage is the lack of any leaching of salts from the soil profile. Sometimes the soils have elevated salt levels at the end of the season near the top of the soil profile but winter rains usually leach these out by summer crop planting time. While it is not causing any problems, it is very important to be mindful of water quality.

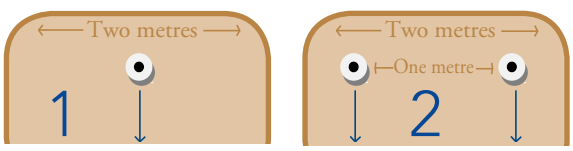
Managing crop residues has been one of the keys to success but also a real challenge. High yielding crops produce plenty of stubble, which needs to

Stewart's must-do's for effective sub-surface drip irrigation

Keeping an eye on Quandong

- Good design is critical to ensure enough water can be delivered to the crops.
- Make sure all valves are run at correct pressure.
- Design the system for more pressure rather than just enough pressure. One day you will need it and pressure is your best friend when it comes to drip irrigation.
- The biggest cost is energy associated with pumping the water. Budget accordingly.
- Be wary of long run lengths for high yielding crops. I don't like driving all over my county with grain chaser bins and cotton boll buggies during harvest. We want to keep out of the fields as much as possible to protect our soil structure. It is not easy to repair wheel track damage in drip irrigation fields, so we are pedantic about avoiding wheel track compaction.
- High emission uniformity across the system and sub-mains is critical. This will determine the correct run length
- The soil structure must be in good order before installing drip irrigation. It also must be kept in good condition by incorporating trash and practicing minimum tillage.
- Drip irrigation is just like running a swimming pool. To succeed keep it clean, back wash it, flush it once per week and you won't have any problems. Use chlorine and acid when needed
- The sub-surface drip tape depth is critical. Six to eight inches is ideal in red soils. If the tape is too deep, subbing water upwards towards seeds can be problematic. In black soils the tape can be deeper: ten to twelve inches.
- My earlier irrigation designs had a drip tape in the middle of the two-metre beds. The newer installations have drip tapes one metre apart, which is better for subbing water upwards and for winter crops row spacings.

Dripper tape spacings



1. Previous configuration of dripper tapes in run length
2. New configuration of dripper tapes

be managed. Cotton and corn stubble is moved toward the centre of the bed and sits on top of the sub-surface drip irrigation tape. Thus soil organic matter levels have been increasing, as all the dry matter is kept in the system. High yielding crops produce plenty of organic matter, which improves soil structure and protects the soil surface.

"Make sure your sub-surface drip system has plenty of pressure for flushing. Pressure is your best friend."

Stewart Crawford

The Future

Looking towards the future, any new sub-surface drip installations will have a one metre tape spacing. This makes it easier to wet the soil upwards and has a better fit with winter grain crops.

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