New developments in wicking bed technology

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There have been four major events in the development of the wicking bed technology.

First is the establishment of a wicking bed test site at the Farmland Irrigation Research Institute in XinXiang China.

The second is the post mortem on the wicking bed trial site in Gin Gin Australia following the devastating floods.

The third is finding a researcher in Serbia, Europe who has developed a machine for laying plastic film.

The forth is the introduction of a carbon trading scheme in Australia.

Together these are highly exciting with a vision of how wicking beds can be used in the immediate future.

Miro's film laying machine

Miro Medjo, an independent researcher in Serbia, Europe has developed a machine for laying plastics film. This machine is towed behind a tractor and can lay plastic film in one pass. Essentially the film is passed through a slot in the direction of the tractor movement, then the film is rotated through 90 degrees to form the bed.

This machine looks as though it could provide a way of laying large areas of film very cheaply.

This machine was initially developed for light sandy soils where any rainfall would pass straight through the soil with little water being retained. It relies on natural rainfall to fill the bed and there is no provision for laying pipes or adding organic material to the bed. I also understand from Miro that with heavy soil it is necessary to do two passes, one to break up the soil the next to lay the film.

This machine has the potential to lay large areas at very low cost. Our experience is that the bed itself will hold enough water for may be a month so there needs to be a way to add water to the bed.

Here experiences with recovering wicking beds after the Queensland floods are useful.

The Queensland floods

Let me start by describing the effect of the Queensland floods on the wicking beds in Gin Gin.

The floods were not a single event. We experienced frequent heavy rains which totally saturated the soil. Previous experiments have shown that it takes over a 100mm of rain before there is any surface flow. When the major flooding rains came the soil was both saturated and softened immersing the test site in muddy water. But even after the main flood there were still high levels of rain which meant the test site was essentially submerges in muddy water for some three months.

Upon my return from China I started to restore the site. By that time weeds had grown to waist height overgrowing much of the productive crops so the only option was a long and tedious process of manual removal. Many plants which had been planted at surface level had died from the long period of saturation while those planted on raised beds had largely survived.

The beds constructed with a subsurface pipe to distribute the water were found to be in virtually perfect condition once the weeds had been cleared. The wicking beds using a raised bed and subsurface pipe design are clearly resilient to a flood and drought cycle.

However pipes are expensive and having beds which required individual filling is time consuming for commercial use. For this reason the last beds created had not used a pipe to distribute the water. Instead experiments were aimed at finding a low cost alternative. These test include combinations of wood chips, bubble wrap, sticks etc.

After the floods the resilience of the beds were evaluated to assess the ruggedness of each system to cope with adverse weather. As said the system using subsurface pipes survived the flood without damage. The system in which short sticks were laid in the bottom of the trench then covered with a second sheet of plastic also survived well with just a small reduction in maximum allowable flow rate, (the maximum rate at which water can be applied without causing flooding in the area where water is applied).

The soil in the beds where we had used wood chip mulch was beautiful, it has a open texture and was full of worms which are a good indicator of soil health and keep the soil open.

It should be pointed out that the organic material and wood chips we use are different to used in China.

We use a product called mill mud (or filter press) which is a waste product of the sugar industry. It is a mixture of the fine soil particles mixed with the outside of the crushed cane. It is very high in organic content and organic life and will readily decompose and develop fungi without any assistance.

The second material is what we call wood chips but could probably better be called forest clippings. A machine goes through wooded areas either chopping off branches and mulching them up or mulches up whole trees. (I will make a video shortly). The mulch is a mix of the hard lignin from the trunk plus all the leaves and twigs and again is full of nutrients.

Flow rates - sequential or concurrent filling

There was however one problem with these beds filled with wood chips; - the maximum allowable flow rate without flooding was much reduced. This increased the length of time to fill each bed.

I felt that the amount of labour in filling beds individually was too high and so wanted to link the beds together so multiple beds could be filled. The system I first used was sequential, e.g. the first bed would be filled then water would overflow into the second bed until that was filled than again the next bed would be filled. This was the system I recommended and was adopted in China.

When first installed this worked well as a high water flow rate could be used so that each bed was filled between ten or thirty minutes.

However after the floods, when the beds relying on wood chips were immersed in muddy water for some three months, a significant amount of mud had infiltrated down into the base of the bed. Water would still flow along the bed but at a much reduced rate. This meant that a much

lower flow rate had to be used with a longer time to fill each bed. This meant that using the method of sequential filling that the total time to fill all beds was becoming excessive.

It was therefore decided to alter the beds from sequential filling to concurrent filling so that even though the time to fill each bed may be increased the total time to fill a family of beds would still be reasonable. This decision was strongly influenced by the potential of Hiro's film laying machine.

Experiments for adapting wicking beds for Hiro's film laying machine

Hiro's machine lays pipe directly into the soil so it is not possible to lay pipes or have multi layers as we have been using with manually made wicking beds. Up until now we have had to make trench to be lay the plastics so laying a pipe or installing a lower layer of wood chips was easy. Hiro's machine lays the film directly into the soil so other ways of getting water into the wicking beds is needed.

One easy way would be to put a layer of organic material on the surface and mix this into the soil using a plough or rotary hoe. This would break up the soil so film could be laid in heavy soils. However there is the problem of how to get the water to flow through the soil at a reasonable rate.

Two experiments were conducted. In the first the method of filling the beds was changed from sequential to concurrent filling. This was very simple, a 19mm pipe was laid down at the edge of the beds with T pieces branching off to a tap to fill each bed. There was a question of whether the taps could be adjusted to give a balanced flow to all the beds so they would receive the required amount of water in the filling time.

We have three sets of wicking beds. The first two are open beds feeding an orchard with 8 and 9 beds of average length 15 meters. One bed was extended to a total length of 30 meters.

The third are 10 closed beds in a green house.

It seemed relatively easy to adjust the taps to give balanced flows in each set.

One of the open orchard sets was then linked in with the green house beds, these are short beds filled using a pipe with entirely different water and flow requirements. The total number of beds linked together then totaled 19. This proved significantly more difficult to 'tune' to get balanced flows, but was still possible. There seems good reason to think that with similar beds and

with a little calculation on flow restrictors that families of up to 20 beds would be entirely practical.

This corresponds to an area of 1,000 meter squares being irrigated from one point which is economically viable.

All the beds including the 30 meter bed filled to the end without problems. However these beds are new with fresh wood chips covered with mill mud so they can be expected to slowly silt up over time. How long it would take for them to silt up is unknown as is the final flow rate after silting. With the action of worms to keep the soil open and porous they could still be viable for long periods of time.

However it was decided to resurrect an old bed that had been installed over 5 years ago and had been discarded as more modern wicking bed design evolved. The soil in this bed had totally consolidated.

The edges of the bed, left exposed to sunlight and traffic had badly deteriorated where they had been left uncovered but the film under the soil was still in good condition. The water would not readily flow through the compacted soil however a small (50mm) trench was dug to act as a micro furrow channel. The water then rapidly flowed to the end of the bed.

This looks just like conventional furrow irrigation (which should make it readily acceptable to traditional farmers) but unlike furrow irrigation the water is not lost by soaking deep into the soil beyond the root zone. Obviously in an open bed wicking bed there will be some loss of water as there will be leakage and wicking into the surround soil but is thought to be negligible in comparison with conventional furrow irrigation.

No trials have been conducted to estimate the loss of water however I have significant experience with furrow irrigation in my soils and have a good feel for how fast the flow front travels along the bed. Of course this is not constant but varies with the water content of the soil, in a wet soil the flow front will move fast while in a dry soil there will be significant cracking so the water penetrated deep into the soil until the soil has swelled and is water resistant.

I can say that the flow front velocity in these furrow irrigated wicking bed is far faster than in a conventional furrow. This would indicate that the loss of water is small, certainly a quantum improvement on conventional furrow irrigation.

However furrows can be very inconvenient when machinery has to be used for mowing or weed clearing. The next experiment is to enlarge the furrow and fill with wood chips. This would continuously top up the soil with fresh organic material. This experiment is currently underway.

Soil carbon

Next week is the soil carbon conference, I will report on this separately but I should point out that the soil carbon bill enabling farmers to trade carbon has already been passed and the carbon trading bill is currently before parliament. A feature of this bill is that it allows international trading of carbon which would mean that Chinese farmers could trade their carbon saving at $35 per tonne of atmospheric carbon.

Sloping land

Normally wicking beds are installed horizontally along a contour line. However we had an existing area which had been planted with mangoes and we did not want to move the plants.

The technique used was to make a sloping bed with deeper holes by each tree. The plastics was laid and filled with wood chips then mill mud. The water flowed from hole to hole so each hole acted as a local wicking bed. So far this appears to be an effective method of irrigation on sloping land with existing trees.

Conclusion

The Miro film laying machine offers a potential method of installing wicking beds very economically. The beds can be filled with water by mixing organic material with the soil before laying the film. Multiple beds can be filled concurrently using a simple distribution pipe with T pieces and a tap to control the flow rate to each bed. When first installed water will flow through the broken soil and wood chip mix at high flow rates.

Over time the soil will consolidate which will reduce the maximum flow rate at which water can be applied without flooding. This may not be a problem but beds can easily be upgraded by

making a small furrow. This could be filled with fresh wood chips to provide a continuous source of organic material.

This is a very simple and rugged system which has significant potential for commercial use.

The routine top of wood chips would provide ongoing source of revenue for the farmer by carbon trading.