HOW MUCH IS RAINFALL WORTH?

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A recent study by agronomists in the Lachlan cropping zone has calculated that every millimetre of rainfall stored as soil water is worth around $4.50 per hectare. This figure was based on a water use efficiency of 20 kg/ha/mm rain at a price of $225.00 per tonne. With improved soil health and a stubble retention program it has been shown that water use efficiency figures of greater than 20 kg/ha/mm rain are achievable and with grain prices in the $400 to $500 per tonne range the value of stored water is in the range of $8 to $9 per millimetre of rain. Therefore the figures used to calculate the results presented below could be regarded as conservative.

Base data for the article were obtained from a rainfall simulator demonstration at the recent Condobolin Conservation Farming Field Day in February 2008 can be used to calculate the real cost of lost rainfall as runoff due to poor surface soil structure.

A rainfall simulator is a piece of experimental equipment that mimics rain at a constant rainfall rate with a droplet size and velocity equivalent to actual rain. This provides data such as time it takes for the soil surface to pond and runoff to occur, the total runoff amount and the soil infiltration rate (runoff rate) during a storm when the soil is wet. These are determined by the applied rainfall rate and the effect of the raindrop impact on the soil surface or a surface cover on the soil surface. The results provide a simple but powerful message about the stability of a bare soil to raindrop impact and the effect of surface mulch to protect the surface soil. It is also possible to measure the amount of soil and nutrients lost. For demonstration purposes this is difficult to measure due to drying time and analysis requirements. However the sediment can be visually assessed from the runoff collected by observing the colour of the runoff and the thickness of the settled soil in the collection jars.

What happened at Condobolin?

The simulator was set up on a settled cropping paddock that had produced a low yielding wheat crop in 2007. The soil type was a calcareous red earth with a long history of cropping/pasture rotations. Inspection of a soil pit dug next to the simulator and the analysis of a soil test showed the surface soil has severe structural problems with compaction down to 20cm and a low organic matter level (1.2%).

A demonstration was set up by inserting a square metre plot edging into the soil with a catchment tray to catch runoff soil and water.

The plot was split into two treatments:

All the stubble removed, cultivated to 10cm and levelled similar to a harrowed paddock;

The soil surface was left undisturbed with 4 tonne/ha (a crop yield of about 2.2-2.5 tonnes/ha) of flattened straw on the surface.

A rainfall rate of 43mm per hour was applied over a 36 hour period. The rain was applied in 6 X 15 minute storms of 10.75 mm - the total rain applied was 64.5 mm.

The results of the storms are shown in table 1 below.

Table 1: Water Infiltration in Ploughed plots and stubble-covered plots

	Ploughed Plot	**Stubble-covered plot**
First rain		
15 min (10.75mm total rain)		
Time to surface sealing	4 minutes	N/A
Time to run-off	6 minutes	N/A
Run-off Collected	2mm	0
Second rain		
15 min (21.5mm total rain)		
Time to run-off	<2 minutes	10 minutes
Run-off collected	8mm	0.4mm
Third rain		
15 min (32.2mm total rain)		
Time to run-off	<2 minutes	10 minutes
Run-off collected	12mm	1.6mm
Fourth rain		
15 min (43mm total rain)		
Run-off collected	12mm	2mm
Fifith rain		
15 min (53.5mm total rain)		
Run-off collected	4.8mm	2mm
Sixth rain		
15 min (64.5mm total rain)		
Run-off collected	7.3mm	1mm
Total Rain Applied=64.5mm	**46mm run-off**	**7mm run-off**
Total infiltration	**18.5mm**	**57.5mm**

What does this mean?

Some of the key points:

Despite the soil being in a freshly cultivated condition, it took only 4 minutes to surface seal the soil and 6 minutes for runoff to commence. This was due to the rainfall

Impact energy on the unstable surface soil that rapidly slaked (melted) to form a surface seal. Where the 4 tonne of stubble per hectare (100% ground cover) was left, the rain was not able to impact on the soil surface and seal it as much. This resulted in an infiltration rate of only 18.5 mm in the ploughed plot and compared to the stubble plot of 57.5 mm.

When the subsequent rainfall events were applied, runoff from the sealed ploughed surface commenced in around 2 to 4 minutes. This time depended the period allowed for the soil drain and dry before the next rain event. This is the reason for the differences between the runoff collected from different storms.

When a steady runoff rate was obtained during a rain storm event the runoff rate was close to the rainfall rate from the ploughed plot (>90%). This means that there was virtually no rainfall infiltration in the ploughed plot when the soil became saturated and ponded from the rain.

The soil loss from the ploughed plot was significant. Once the soil settled in the collection containers there was on average around 2 mm of sediment on the bottom. There was no sediment from the stubble block just slightly discoloured water

How much money did we loose?

Using the calculation of $4.50 for every millimetre of rain stored as soil water then the money or potential productivity loss from the ploughed block compared to the stubble can be estimated from two aspects:

If the rain was received in the fallow period and using a fallow efficiency of 30% then the potential production loss was

39mm X 0.30 = 11.7mm X $4.50 = $53 per hectare

If the rain was received in crop then potentially all of the rain can be used……

39mm X $4.50 = $175 per hectare

These calculations do not factor in the nutrients lost in the sediment. Studies from similar settled soil conditions and soil type have had soil losses of 1.8 tonnes per hectare from the same rainfall rate applied for 40 minutes. This would represent a soil loss of greater than 4 tonnes per hectare for the 90 minutes of rain applied. For a sandy loam soil this figure would be more than 9 tonnes per hectare over the same period. To estimate the loss of nutrients the results from a severe storm in 1992 at Cowra can be used. The rain event was 81 mm of rain in 45 minutes with an average rainfall intensity of 108 mm/hour and a peak intensity of 360 mm/hour for two minutes. It was estimated the soil

loss from the ploughed plot was 360 tonnes per hectare which contained > 300 kgs /ha of nitrogen and >15 kgs/ha of phosphorous as well as other essential elements. Using this as a guide then for every tonne of soil lost a conservative estimate would have been between 4 – 9 kgs/ha of N and 1 -2 kgs/ha of P. Remember this estimation is for the relatively gentle application of 64 mm rain over a 36 hour period. Storms well in excess of this have been received in the summer of 2008 and losses would have been much higher.

Therefore potential production losses just from runoff alone was greater than $50 per hectare if the rain was received in the fallow period and greater than $170 if received in the growing period. Realistically the cost of the nutrients lost should be factored into these costs as well as the devastation of losing soil from sheet erosion. Soil is a non renewable resource and cannot be replaced.

The maintenance of stubble on this soil significantly protected the soil from raindrop impact and subsequent soil surface sealing. Over time with reduced soil disturbance and return of residues soil by adopting no tillage practices soil matter and structure will further improve infiltration and also provide protection from raindrop impact when the stubble cover is low.

As a final note have you measured how much of the water has been stored in your soil profile? Although the infiltration rate is dependent on soil type and condition, this demonstration does highlight that a majority of the rain received in this wet summer period may have been runoff and the soil may have relatively little stored water.