Soil erosion assessment and management

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The aim of this project was to assess the impact of the 2006 drought on soil resources of the Mallee region, and to identify preventative means for soil stabilization. The project assessed the relative benefits of different farming systems for soil erosion control and conducted quantitative assessment of soil erosion to allow the validation of current techniques for assessing soil erosion potential.

Take home messages

- *Relatively low levels of stubble cover during January – March provide effective protection against soil erosion.*
- *Protection against soil erosion is not related to the tillage system employed in crop establishment or management provided stubble is retained over the summer period.*
- *Ripping techniques in which significant levels of clod are brought to the soil surface are effective in preventing significant soil losses on paddocks without vegetative cover.*
- *Burnt paddocks or heavily grazed lucerne pasture paddocks have the highest erosion risk potential.*
- *There is a need to improve pasture management practices, especially for perennial pastures.*
- *Crop management practices, principally the move to stubble retention in cropping systems, and the high percentage of cereals in crop rotations, represent low soil erosion risk activities during the summer period.*
- *Cultivation between March and crop establishment remains a soil erosion risk, especially if there are low levels of stubble.*

Methods

Paddocks were chosen to represent a broad geographic area across the Mallee and, where possible, included paired paddocks that allowed contrasts of farming systems or landforms within a given geographic area.

18 paddocks chosen were sown to a cereal crop in 2006, and two paddocks were perennial pastures.

Volumetric soil moistures to a depth of 100cms were recorded on two occasions (early December and early March) from 13 paddocks, including 12 paddocks representing six pairs of paddocks with contrasting farming systems (No-Till versus Tilled).

During January 2007 the risk of soil erosion was assessed at all sites using the method of Leys (2002), where soil flux is calculated as a function of vegetative cover and soil aggregate size. Each paddock was assessed in triplicate and results expressed as an average of the replicates. For sites where soil erosion was detected during the course of this project, the risk assessments were repeated in April 2007.

Relative soil erosion from each paddock was measured using the Modified Wilson and Cooke (MWAC) aeolian dust sampler (see Goosen and Offer, 2000), with five samplers (at 5, 10, 15, 25 and 100cms intervals) attached to PVC piping fitted with a wind vane. The PVC pipe was in turn placed over an iron post, allowing the wind vane to rotate the piping so that the samplers were always orientated into the wind. The sampling "posts" were placed in triplicate on the eastern edge of each paddock, assuming the majority of soil erosion in a given paddock would stem from winds from a westerly direction. Dust samples from each paddock were collected on two occasions, the first being over the two days 5 and 6 March (here-in-after referred to as the 6th March collection date), and the second occasion being on the 27 March, when the dust samples were collected from all sites on a single day. For ease of interpretation, results are presented as averages of the total soil collected in the three lower dust samplers from each "post" in each paddock. Calculations of vertical soil flux can be made by integrating the area under the power curve generated from a plot of the five sampling heights.

Results

Soil Moisture

Figure 1 shows the volumetric soil moisture for 1m cores for six paired paddocks, representing No-Till and Till farming practices in six districts taken immediately after harvest in early December and again in early March. On average the Tilled paddocks had, respectively, 27 and 24mm more soil water at these sampling times, suggesting more effective water use during the 2006 growing season by the No-Till crops but no difference in summer soil moisture conservation between the farming systems.

Few conclusions can be drawn from the comparison of the farming practices (No-Till versus Till) based on the sampling period of this project. Due to the nature of the season, farmers utilising either of the farming systems retained their stubbles from harvest through to March and used chemical weed control over the summer period. Differences in soil moisture conservation between the farming practices may have become apparent in the period March – June during which time cultivation in the Till farming systems is conducted prior to sowing.

As part of this survey, a paddock in the Wooroonock district, which had been partially denuded by a bushfire in late November 2006, was also monitored. Areas of the paddock that had been burnt had been ripped, as a means of soil erosion control, whilst other areas of the paddock, untouched by the fire, retained stubble cover. Soil moisture levels were determined in January from a series of cores taken from each portion of the paddock (see Figure 2). Soil moisture levels were significantly higher in the stubble area at all depths except the surface layer.

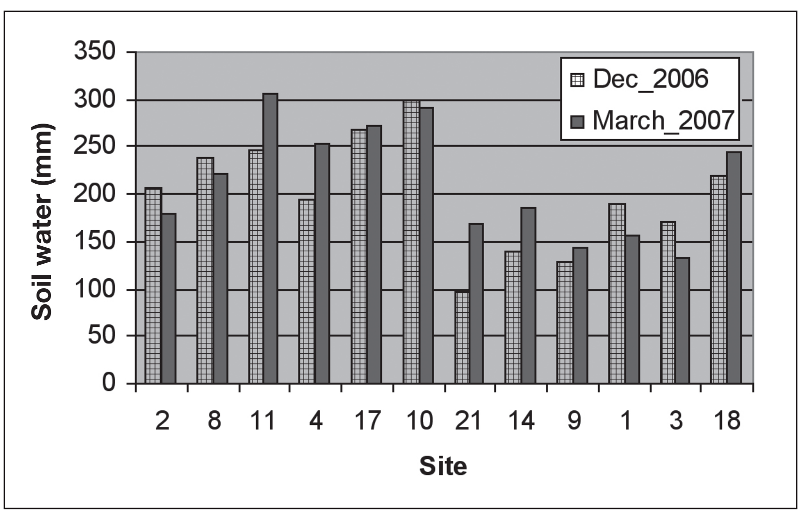

Figure 1: Volumetric soil water content to a depth of 1m for twelve sites, consisting of six paired paddocks representing No-Till and Tilled farming practices respectively. Sites are ordered from L to R as follows: Culgoa No-Till (2), Culgoa Till (8), Donald No-Till (11), Donald Till (4), Minyip No-Till (17), Minyip Till (10), Patchewollock No-Till (21), Patchewollock Till (14), Sea Lake No-Till (9), Sea Lake Till (1), Yaapeet (3) and Yaapeet (18).

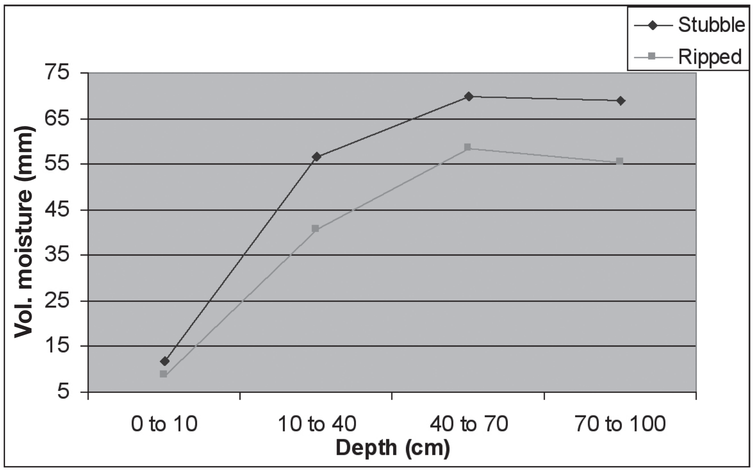

Figure 2: Volumetric soil moisture to a depth of 100cms from Wooroonock Sites 19 (Stubble) and 20 (Ripped) when sampled in January 2007.

Soil Erosion

Soil erosion potential, as determined by the method of Leys, for each of the paddocks is presented in Table 1. Using this method all paddocks represented a low soil erosion risk (Q < 5). Values of both vegetative cover and soil aggregate size determined using this method were generally relatively high.

Figure 3 indicates that, in general, little soil loss was detected from the majority of paddocks. Soil loss from those paddocks with stubble cover was often below detectable limits. In paired paddock comparisons, there was no difference in soil loss from the No-Till versus the Tilled paddocks, due to good stubble retention under both farming practices.

However, two paddocks (Wooroonook Sites 12 & 13 and Waitchie Site 15) suffered considerable soil loss and raised questions about the usefulness of the Leys assessment methodology for predicting soil erosion in this environment.

The Wooroonook Sites 12 and 13, represented non-ripped and ripped treatments in a paddock denuded of vegetative cover by fire in late November 2006, incurred substantial soil losses (Figure 3) despite Q values of less than 1.0 at the time of the January erosion risk assessment (Table 1) and values of 2.0 or less when assessed during April 2007 (Table 2). The treatment chosen by the grower to reduce soil loss following the fire consisted of ripping the paddock in strips approximately 20m apart. An area of the paddock was left unripped allowing a comparison of the effectiveness of the treatment. Figure 3 shows clearly that the ripping strategy employed provided very little reduction in soil loss (see Figure 3, Sites 12 (non-ripped) and 13 (ripped)). The cultivated swathes produced too little clod and were too widely spaced to reduce effective wind speed on the soil surface.

In comparison, a second paddock surveyed in the Wooroonook district, which was also denuded by the fire of late November 2006, was cultivated in total, raising considerable clod (Site 20). An area of the paddock which had not been burnt, and in which standing stubble remained, was used as a comparison (Site 19). For Site 20 there was little evidence of soil erosion (see Figure 3), with total soil loss, as detected by the soil monitors, only marginally greater than the soil loss detected from the area of standing stubble (Site 19).

The Lucerne paddock at Waitchie (Site 15) also recorded substantial soil loss (see Figure 3), although the erosion risk assessment (Q) value was only 1.19 and well below the threshold value of 5 of erosion risk. A combination of heavy grazing and drought had resulted in low levels of vegetative cover. Minimal soil loss was recorded in the paired paddock in this comparison (Site 16) even though the paddock was protected only by a thin cereal stubble; cereal crop yields in this paddock were only 0.4t/ha and yet the residual stubble, and some stubble retained from the 2005 season, were sufficient to prevent erosion from this paddock. A second erosion risk assessment of the Waitchie (site 15) paddock conducted on 11th April rated the paddock as having moderate erosion potential (Table 2).

Table 1: Soil erosion potential of the twenty paddocks assessed during January 2007 using the method of Leys, where the value Q provides an estimate of erosion potential. Erosion potential is rated as low if the Q value is less than 5, is rated moderate if the Q value is less than 25, and is rated high if the Q value exceeds 25.

Site	Location*	Treatment	Farming system	Erosion Potential	Q g/m/s	% Cover	% Dry Agg
1	Sealake	Cereal stubble	Conventional	Low	0.04	76	95
2	Culgoa	Cereal stubble	No-till	Low	0.11	65	83
3	Yaapeet	Cereal stubble	No-till	Low	0.27	47	83
4	Donald	Cereal stubble	Conventional	Low	0.25	46	86
5	Birchip	Ripped	Conventional	Low	0.91	17	92
6	Hopetoun-A	Lucerne pasture	Pasture	Low	1.19	48	44
7	Hopetoun-B	Failed vetch pasture	Pasture	Low	0.57	61	45
8	Culgoa	Cereal stubble	Conventional	Low	0.45	34	87
9	Sealake	Cereal stubble	No-till	Low	0.11	72	75
10	Minyip	Cereal stubble	Conventional	Low	0.13	59	86
11	Donald	Cereal stubble	No-till	Low	0.42	37	86
12	Wooroonook-A	Non ripped	Conventional	Low	0.12	54	94
13	Wooroonook-A	Ripped	Conventional	Low	0.26	41	93
14	Patchewollock	Cereal stubble	Conventional	Low	0.52	42	74
15	Waitchie-A	Lucerne pasture	Pasture	Low	1.19	42	52
16	Waitchie-B	Cereal stubble	Pasture	Low	0.14	80	57
17	Minyip	Cereal stubble	No-till	Low	0.52	39	77
18	Yaapeet	Cereal stubble	Conventional	Low	1.14	22	80
19	Wooroonook-B	Non ripped	Conventional	Low	0.06	73	86
20	Wooroonook-B	Ripped	Conventional	Low	0.32	41	87

Comparisons within the same paddock are designated by the same suffix letter (eg Wooroonock-A)

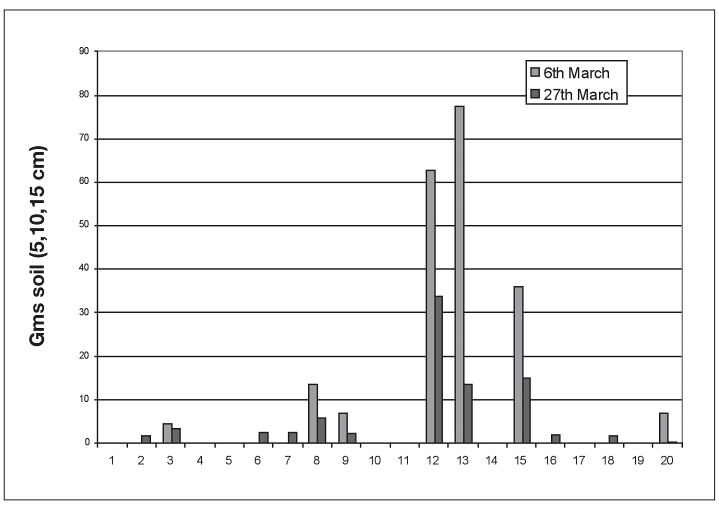

Figure 3: Relative soil loss (grams) collected using MWAC aeolian dust monitors at each of the monitored paddocks on two sampling dates (6 and 27 March). Losses are the sum of the three lower monitors averaged over the three replicates per paddock.

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The erosion assessment method of Leys was used to again assess the potential for soil erosion at the Wooroonook and Waitchie paddocks on 11 April (Table 2). Despite the substantial erosion evident at Sites 12 and 13, the indexes were relatively poor indicators of this erosion potential. A similar situation existed at Site 15, although this site was rated as having moderate erosion potential.

Clearly in these two cases there are inconsistencies between the predicted erosion potential, based on vegetative cover and soil aggregate size, and actual soil loss. The development of the relationship between soil flux (Q) and vegetative cover and particle aggregation occurred using a wind tunnel with constant velocity and a cultivated soil surface. It appears that the relationship developed is underestimating erosion potential on non-cultivated paddocks.

Table 2: Soil erosion potential of the Wooroonook and Waitchie paddocks when re-assessed using the method of Leys in April 2007.

Site	Location	Treatment	Farming system	Erosion Potential	Q g/m/s	% Cover	% Dry Agg
12	Wooroonook-A	Non ripped	Conventional	Low	1.87	21	69
13	Wooroonook-A	Ripped	Conventional	Low	2.03	31	52
15	Waitchie-A	Lucerne pasture	Pasture	Moderate	7.80	8	49
16	Waitchie-B	Cereal stubble	Pasture	Low	0.65	50	57

Commercial practice

The level of soil erosion was very low across the region, due largely to the management practices adopted by growers. Whilst in this survey significant soil loss was detected at 15% of sites, some of these sites had been deliberately selected as representing a high risk and a more realistic estimate would be less than 5% of paddocks represent a serious erosion risk.

Good erosion control is achieved by maintaining a high percentage of surface cover (greater than 50%) and sufficiently coarse soil aggregate size. The standard measurement of soil aggregate size is to measure the relative percentage of soil retained above a 0.85mm screen; soils with greater than 70% retention over a 0.85mm screen are considered sufficiently coarse to minimize erosion. Even relatively low levels of stubble cover provide good protection against erosion. If these conditions are not being met, then soil "roughing" may be required. There is not one single approach to achieving this goal. If there is no requirement for the use of the paddock for livestock, then full cultivation with narrow points bringing up soil clods will achieve a satisfactory result. If there remains a need to graze the paddocks, then the use of widely spaced "ripper" tynes may be the best approach.

The results from these surveys have indicated that, in general, the currently employed conventional and no-till farming systems represent little erosion risk in the January to March period following a drought. It is worth noting that none of the paddocks included in this study were mechanically fallowed, and none had been sown to legumes in 2006. The main paddocks with erosion potential were those that had been heavily grazed. Management of pasture paddocks, particularly perennial pasture paddocks, is the area requiring the greatest improvement to ensure soil erosion levels remain at low levels.

References

Goossens, D., Ower, Z.Y. (2000). Wind tunnel and field calibration of six aeolian dust samplers. Atmospheric Environment 34: 1043-1057.

Leys, J.F., Semple, W.S., Raupach, M.R., Findlater, P. and Hamilton, G.J. (2002). Measurement of size distributions of dry soil aggregates. In: "Soil physical measurement and interpretation for land evaluation". Pgs: 211-220. Eds: McKenzie, Coughlan and Cresswell. CSIRO Publishing, Collingwood, Victoria.