Mallee Soil Erosion and Land Management Survey

Post Sowing 2011

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Mallee Soil Erosion and Land Management Survey
Post sowing 2011

August 2011

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Prepared for: Mallee Catchment Management Authority

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Purpose of Report

This report provides the results of the 'Mallee soil erosion and land management survey'. The report is divided into two parts. The first part of the report provides a summary of trends over time in soil erosion risk and land management practices for the Mallee sites surveyed. The second part of the report provides the results from the Post Sowing 2011 survey.

Trend Summary

Background

Wind erosion occurs naturally in the landscape and is an important part of soil genesis; many soils in the Mallee have formed by aeolian processes. However wind erosion also causes adverse effects through the removal of large amounts of fine soil particles that result in a direct loss of nutrients from agricultural land as well as sandblasting emerging crops (Armbrust 1984 as cited in Leys et al 2007). Wind erosion also has considerable off-site impact, the airborne particulate matter can cause adverse health effects, and reduced visibility and the deposition of soil can smother native vegetation, bury or undermine infrastructure and increase nutrient loads in waterways (Clune, 2005).

Wind erosion has been a recognised issue in the Mallee since at least 1945 (Thomas as cited in Clune 2005) and as such has been a priority of Natural Resource Management organisations for many years. This has resulted in extensive promotion and research of agricultural practices that minimise the risk of erosion.

In 1978 the Mallee fallow survey commenced after wind erosion became severe and widespread, particularly in areas with light soils (Boucher 2005a). The objective of this original survey was to assess actual erosion and land use practices in the Mallee region of Victoria. The survey has continued using a number of different methods (Wakefield 2008b).

In 2005-2006 the survey underwent a review and redesign. The results reported in the main component of this report are from the current methods which have been implemented since 2007.

The current survey is conducted three times annually, during late summer (February - March), post sowing (June - July) and spring (October). In-paddock assessments are completed at 157 sites, from across six land systems (Central Mallee, Millewa, Tempy, Hopetoun, Culgoa and Boigbeat) within the Mallee region. Refer to methods section in main report.

The Department of Primary Industries (DPI) Farm Services Victoria (FSV) in partnership with the Mallee Catchment Management Authority (Mallee CMA) conducts the Mallee Soil Erosion and Land Management Survey and manages the Soils and Land Management database with funding provided through the Victorian State Government.

The second part of this report documents the methods used in the surveys as well as analyses of the result of the post sowing 2011 survey. The survey records, soil dry aggregate and vegetation cover and height (risk of wind erosion), and land management practices.

The following graphs illustrate trends over time for the land management practices and vegetation coverage at the sites surveyed.

Land management practices

The survey of land management practices during the 2011 post sowing sampling period showed 3.8% of paddocks in chemical fallow, 3.2% conventional fallow, 18.5% in pasture and 74.5% in crop. In comparison to the same sampling periods of sites in 2010 there has been a decrease in pasture by 7.5%. Results show a similar trend for land management phases over the 5 years of survey at these sites (Figure 1). 2011 saw a slight increase in chemical and conventional fallow compared with previous years. This may have been due to the extreme rainfall events in January and February that inundated paddocks with water, denying landholders timely access to paddocks, influencing management practices.

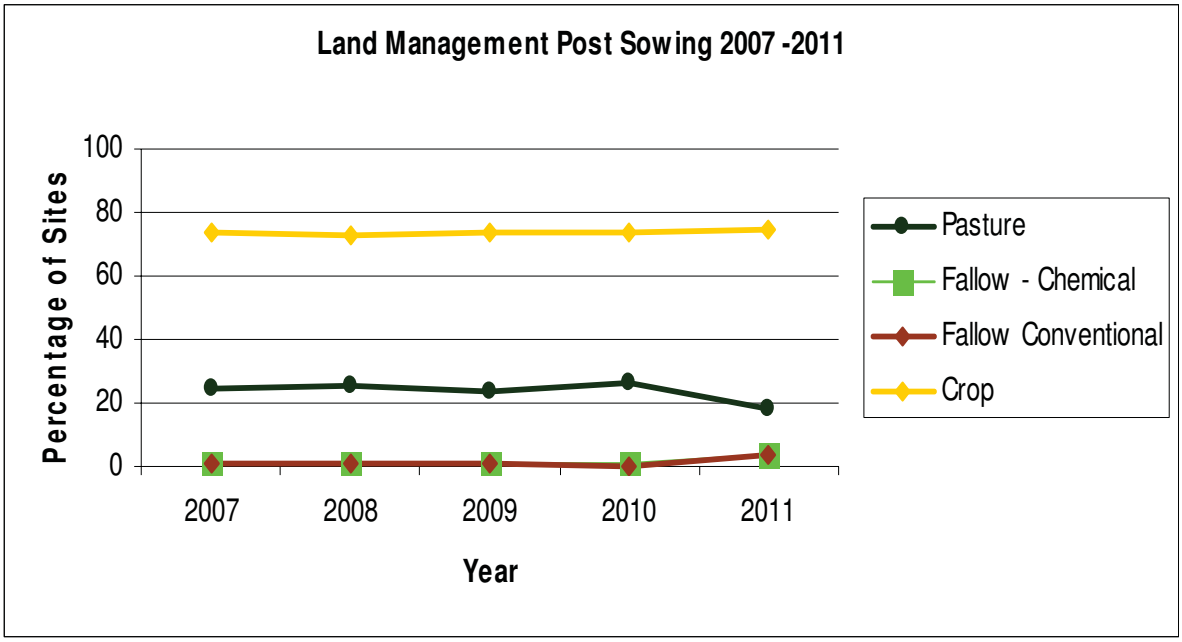

Figure 1: Percentage of sites surveyed in the Mallee under different management practices including pasture and all fallow methods during the post sowing survey.

Vegetation coverage

Vegetation coverage providing a protective canopy of the soil is a key factor in minimising the risk of erosion. The vegetation coverage (Figure 2) in 2008 showed greater than 70% of the sites with less than 10% cover compared with 2009-2011 where greater than 50% of the sites recorded greater than 50% cover indicating a lower risk of erosion (Agriculture Bureau of South Australia, 2002) for these sites over the past three years. Less post sowing rainfall totals were recorded in 2008 then the following years of 2009 - 2011. This may have contributed to 70% of the sites in 2008 having less than 10 percent vegetation coverage.

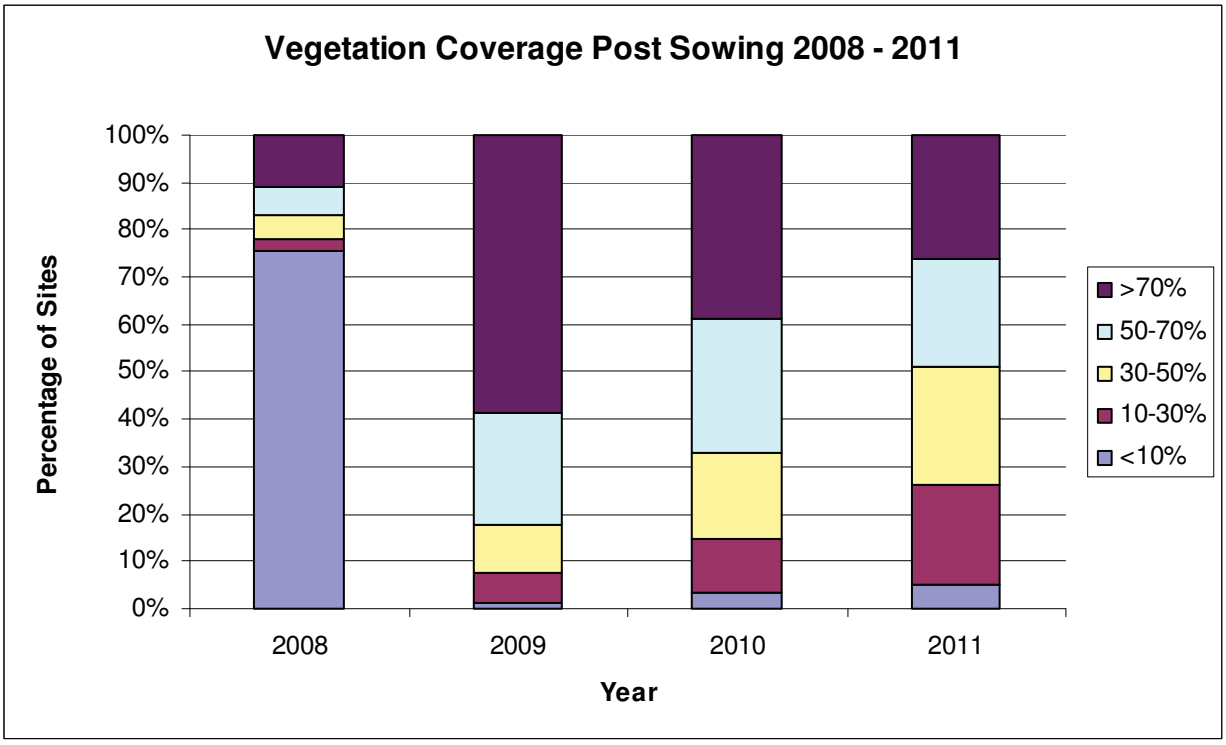

Figure 2: Vegetation coverage of sites surveyed in the Mallee during the post sowing survey since 2008 to 2011.

Conclusion

The survey of land management practices shows a consistent trend during the post sowing (2008- 2011) sampling periods with greater than 70% of sites in crop, 18-25% sites in pasture and a negligible number of sites in fallow.

Vegetation coverage recorded at sites at the post sowing survey, has increased from 2008 when 75.3% of sites recorded less than 10% coverage. Results from 2009 recorded 1.3% of sites with less than 10% vegetation coverage, compared to 3.18 % in 2010 and 5.09% in 2011.

In 2008 rainfall totals were recorded as less during the growing season which may have attributed to the decrease in vegetation coverage.

Vegetation coverage results from the post sowing survey, of greater than 50% (indicating a low risk of erosion) was recorded at 17% of sites in 2008 compared with 82% of sites in 2009, 67% of sites in 2010 and 49% of sites in 2011.

Post Sowing 2011 Report

Background

The Department of Primary Industries (DPI) Farm Services Victoria (FSV) in partnership with the Mallee Catchment Management Authority (Mallee CMA) conducts the Mallee Soil Erosion and Land Management Survey.

In 1978 the Mallee fallow survey commenced after wind erosion became severe and widespread, particularly in areas with light soils (Boucher 2005a). The objective of this original survey was to assess actual erosion and land use practices in the Mallee region of Victoria.

In 2005-2006 the survey underwent a review (Boucher, 2005a) and was redesigned using recommendations from the review (Wakefield 2008b). The focus of the survey now is on assessing risk of erosion and recording land management practices. The redesigned survey was first trialled in the summer of 2007. The survey is conducted three times annually during late summer, post sowing and spring.

The post sowing 2011 survey of soil erosion and land management was conducted during June 6th and completed June 17th of 2011. This report documents the methods used in the surveys as well as analysis of the result of the surveys.

Objectives

The objectives of this project (2011/12) were to:

- Undertake, analyse and report on the "Mallee Soil Erosion and Land Management Survey" three times annually (post sowing 2011, spring 2011, and late summer 2012).
- Deliver targeted communication activities to increase landholder awareness of erosion risk and management tools to mitigate both incidence and impact of wind erosion.

Methods

Survey Transects and Sampling Locations

From across six land systems within the Mallee region approximately 160 sites were selected randomly for continuous in-paddock assessments three times a year, late summer (February/March), post sowing (June/July) and spring (October). For the post sowing survey 2011, 157 sites were surveyed.

Site selection was stratified based on land system. The proportion of sites from each land system was equivalent to the representation of the land system within the major agricultural regions of the Mallee (the area of the survey), for example the Central Mallee land system occupies 50 percent of the survey area (agricultural region of the Mallee), so 50 percent of the 160 sites were located within this land system. Within each land system the sites were also stratified based on land forms (hummock, plain and dune). Again the number of sites on each land form was based on the percent of area covered by that land form within the land system. The data on land systems area and land form area was based on the Rowan & Downes, 1963 report.

Site Locations

The following is a list of the land systems and transects within each land system where the soil erosion monitoring occurs (See Figure 3).

Central Mallee

- Ouyen to Piangil
- Torrita North to Torrita South
- Tutye North to Tutye South
- Murrayville to Murrayville North

Millewa

- Meringur North to Meringur South
- Bambill North to Bambill South
- Karawinna North to Karawinna South

Tempy

- Gypsum to Gama

Hopetoun

- Hopetoun to Yaapeet
- Gama to Lascelles
- Hopetoun to Woomelang
- Hopetoun to Lascelles

Culgoa

- Swan Hill to Ultima
- Culgoa to Lalbert

Boigbeat

- Ultima to Sea Lake

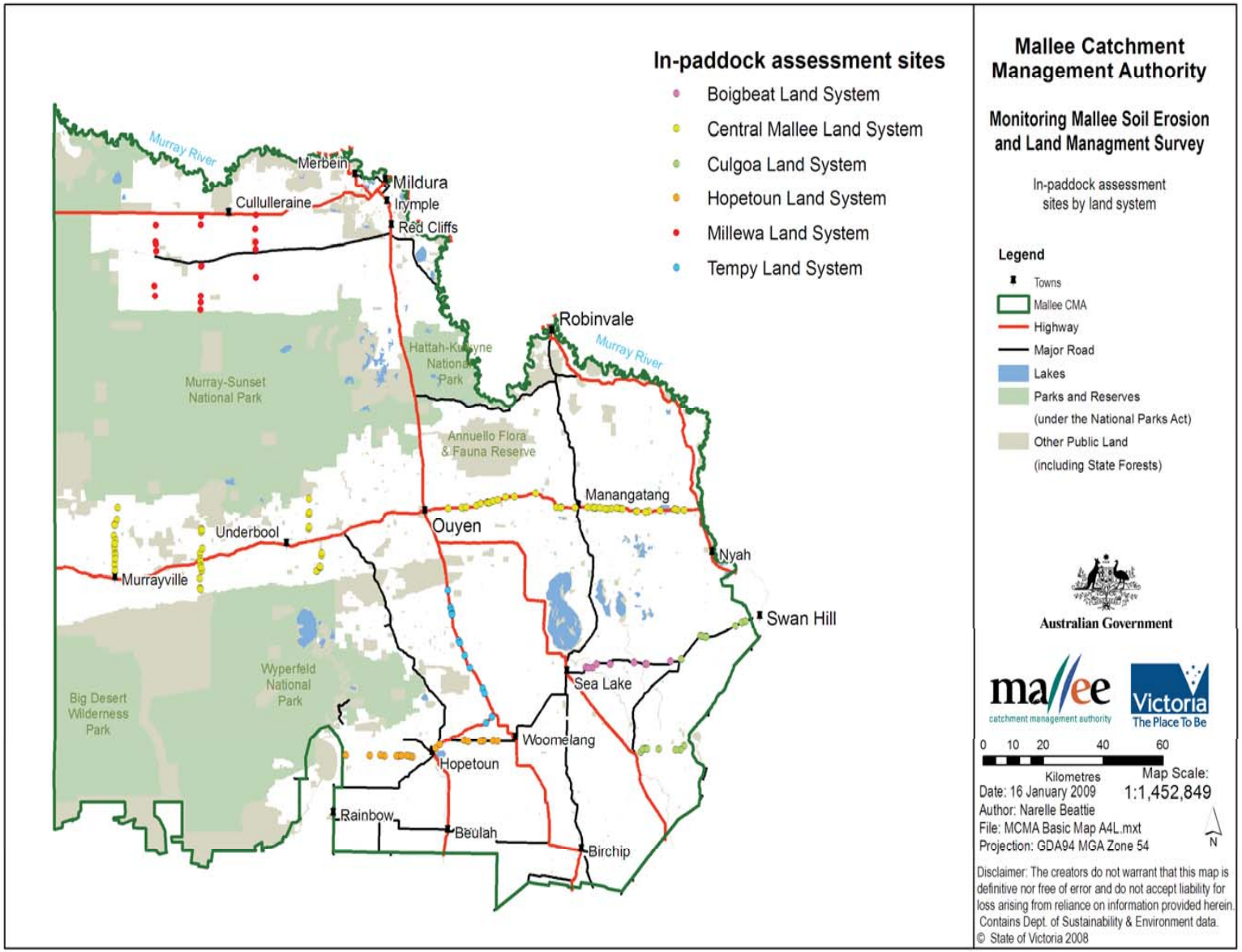

Figure 3: Map of the 157 sites where the soil erosion monitoring is being conducted.

Data Collection

At each site a one hectare area was used for collecting data, this was located 100m along the roadside fence line from the start of the paddock and 50m into the paddock (away from the roadside). At each site the following was recorded:

- Vegetation cover and height measurements.
- Soil dry aggregate measurements.
- The current management phase (i.e. conventional fallow, chemical fallow, crop, pasture).
- The current management practice (i.e. conventional farming or no-till/minimal till).
- The presence/ absence of livestock.
- The presence of standing stubble reported during summer and post sowing surveys.
- Soil detachment rating.

Vegetation Cover and Height Measurements

Vegetation cover was measured using the levy point sampler (Levy & Madden, 1993) (refer to Figure 4). 20 random sites in the one hectare area were sampled to record vegetation cover and vegetation height (200 points). The sampler was placed on the ground (i.e. without looking) 20 times within the 1 hectare sampling area. Five paces south/north then five paces east/west were taken, then recordings taken, and repeated until 20 samples were completed. Vegetation height measurement was recorded by a 40cm ruler attached to the side of the levy point sampler. The height of the closest piece of vegetation (live or dead) to the ruler was measured in centimetres (rounding off to whole number). Vegetation measurements were achieved by counting dead or live vegetation touching the prongs on the levy point sampler.

Figure 4: Levy point sampler used for assessing vegetation cover

Dry Aggregation

From within the one hectare sampling area at each site, 3 points were randomly located for collection of soil samples. Each soil sample was collected using a square nosed hand shovel (or hearth shovel). Approximately 2kg of soil was collected down to a depth of 10cm. It was important to ensure that minimal disturbance was made to the soil, and that the soil was dry when sampling. The soil sample was then placed in an 850µm hand sieve and gently shaken over a baking tray. Both the coarse and fine samples were then weighed and the proportion of coarse aggregates was calculated. This provided an indication of the protection dry aggregates provide against wind erosion (Leys et al 2002).

Land Management Phase

Table 1: Management Phase Descriptions

Chemical Fallow	Land kept free of live vegetation with the use of herbicides with no mechanical disturbance
Conventional Fallow	Land kept free of live vegetation with the use of mechanical cultivation. Visual of up turned earth.
Pasture -Volunteer	Land dominated by random grasses/cereal for grazing
Pasture - Improved	Land dominated by annual broadleaf and/or legume (i.e. clover/ vetch/ medic) used for grazing or green and brown manuring.
Hay	Pasture that has been prepared for hay by evidence of cutting, windrowing or baling. Obvious cut stems on vegetation or evidence of raked vegetation on ground.
Cereal Crop	Wheat, Barley, Oats, Triticale etc
Legume Crop	Field peas, Vetch, Lupins, Beans etc
Oilseed Crop	Canola, Mustard etc
Other	Saltbush etc

Land Management Practice

Table 2: Management Practices Descriptions

Conventional Farming	A system of multiple cultivation control. Passes before sowing for weed and/or seedbed preparation
No-Till/ Minimal Till	Sowing system aimed at minimising soil disturbance and retaining crop residues

Livestock Present

Livestock including sheep, cattle, horses and goats were recorded as present or absent within the site. They are determined to be present if visual evidence of stock, recent scats or hoof marks could be seen i.e. scats were soft, fresh or dark in colour; stock trails could often be seen throughout the area and around fence lines where stock had walked; and/or evidence of footprints and scats around watering points.

Soil Stability Assessment

Table 3 is used as a guide to determine soil surface stability. Each site was assigned a detachment rating based on a visual assessment of soil disturbance. This was a method developed by the South Australian Department of Water, Land and Biodiversity Conservation and used as part of their soil erosion monitoring program (McCord 2008).

Table 3: Soil Detachment Rating (McCord, 2008).

Detachment Rating	Stability	Description
1	Stable	No significant disturbance
2	Slightly to moderately Unstable	Partial soil surface disturbance by: - No-Till (narrow point) sowing - first working with blade plough, prickle chain or harrow - or grazing livestock. Includes any land which has been cultivated at least once: - which has consolidated due to rain (on **loamy** NOT sandy soils) and/or new growth - which is very cloddy and has some residue present - which may have full disturbance but has moderate to heavy residue protection (eg. Cover Rating 4, 3, 2 and some is likely to be anchored) Also includes land with new crop, up until late tillering: - which has partially consolidated due to rain and/or new crop growth. Also includes crops beyond tillering stage - where cover is too poor for complete stability and consolidation is only partial or patchy (eg. drought or erosion affected crop).
3	Very Unstable	Complete soil disturbance by cultivation or heavy grazing (or both). - Includes sowing by full disturbance direct drilling Such disturbance by grazing alone would normally occur only on sand.

Personnel

To ensure timely completion of the sampling during each survey period a number of teams were setup to complete field work in specified areas. Six teams of two people (Table 4) were assembled and completed all measurements and observations at allocated sites. Most teams completed field work in two days.

Table 4: Allocation of transects to teams

Team	Day	Transect	No of sites
1	1	Ouyen Piangil	12
	2	Ouyen Piangil	13
2	1	Torrita	13
	2	Ouyen Piangil	13
3	1	Tutye	13
	2	Murrayville	14
4	1	Millewa	10
	2	Millewa	10
5	1	Sea Lake – Ultima – Swan Hill	15
	2	Sea Lake – Ultima – Swan Hill & Culgoa - Lalbert	13
6	1	Gama - Yaapeet	14
	2	Gypsum – Gama & Hopetoun - Woomelang	19

Data Entry

Field measurements were recorded on hard copy data sheets (Appendix 1) and the data was entered into the database in the office.

A quality control check was completed on the data entered into the database. A 100% check was completed by a staff member not involved in the original entry of the data. A signed quality control form is included as Appendix 2.

Analysis

Erosion risk

For the purpose of comparison three types of assessments of soil erosion risk were completed.
These were:

- Calculation of the 'Q value'.
- Determination of soil erosion risk using a risk matrix.
- Assessment of soil stability.

Q value

A formula has been derived by Leys (Leys et al 2002) to determine relative wind erosion risk. It uses the direct measurements of vegetation cover and soil dry aggregates to calculate a wind erosion risk for each site. The formula is as follows:

$$Q = 78.11375017 * \exp(-0.05172598 * SC\%) * \exp(-0.038989759 * DA\%)$$

Where Q is the calculated sediment transport rate (g/m/s) for an equivalent 65km/h wind measured at 10 m height; SC% is the vegetation cover percentage; and DA% is the level of dry aggregation greater than 0.85 mm as determined by gentle hand sieving.

A Q value of less than 5 g/m/s equates to low erosion risk, moderate risk is a Q value greater than 5 but less than 25 g/m/s and a high erosion risk is a Q value greater than 25 g/m/s.

Soil erosion risk matrix

The measurements of vegetation cover and soil dry aggregates were used to estimate a risk of erosion for each site. The rougher the soil surface the more stable the soil is, vegetation contributes to the roughness. It is recommended that vegetation cover remains above 50% cover to adequately protect from wind erosion (Agricultural Bureau of South Australia, 2002). Larger soil aggregates also protect soil from wind erosion. The larger the aggregates the less likely they are to be picked up and carried away by the wind, larger aggregates also contribute to surface roughness. Dry aggregation greater than 40% has been shown to greatly reduce erosion (Leys, Keon & McTanish, 1996). Table 5 is the matrix that was used to determine the erosion risk using the measurements of vegetation cover and soil dry aggregates.

Table 5: Matrix to determine erosion risk for sites where vegetation cover and soil dry aggregates has been measured (McIntosh, Leys & Biesaga, 2006).

dry aggregates	>50%	30-50%	10-30%	<10%
groundcover				
>70%	low	low	low	low
50-70%	low	low	low	medium
30-50%	low	low	medium	high
10-30%	low	medium	high	high
<10%	medium	high	high	High

Assessment of soil stability.

Completed in the field as described in the data collection.

Results and discussion

Land Management Practices

Land management is recorded during each survey to determine what practices are occurring over the year at sites surveyed within the Mallee region and also to see whether they have any impact on the risk of wind erosion.

The survey of land management practices during the post sowing sampling period showed 3.8% of the sites were chemical fallowed and 3.2% of the sites were conventionally fallowed, and 18.5% in pasture (Table 6 and Figure 5). Conventional fallow was recorded in four of the six land systems.

Table 6: Survey of land management phases during the post sowing 2011 survey sampling period.

Land System	Cereal Crop	Chemical Fallow	Conventional Fallow	Improved Pasture	Legume Crop	Oilseed Crop	Volunteer Pasture
Boigbeat	90.0% (9)	0.0% (0)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)	0.0% (0)
Central Mallee	58.4% (45)	5.2% (4)	0.0% (0)	1.3% (1)	3.9% (3)	6.5% (5)	24.7% (19)
Culgoa	58.8% (10)	5.9% (1)	5.9% (1)	5.9% (1)	5.9% (1)	5.9% (1)	11.8% (2)
Hopetoun	30.4% (7)	0.0% (0)	8.7% (2)	0.0% (0)	39.1% (9)	8.7% (2)	13.0% (3)
Millewa	75.0% (15)	5.0% (1)	5.0% (1)	0.0% (0)	0.0% (0)	0.0% (0)	15.0% (3)
Tempy	80.0% (8)	0.0% (0)	10.0% (1)	0.0% (0)	0.0% (0)	10.0% (1)	0.0% (0)
Total	**59.9 (94)**	**3.8 (6)**	**3.2 (5)**	**1.3 (2)**	**8.9 (14)**	**5.7 (9)**	**17.2 (27)**

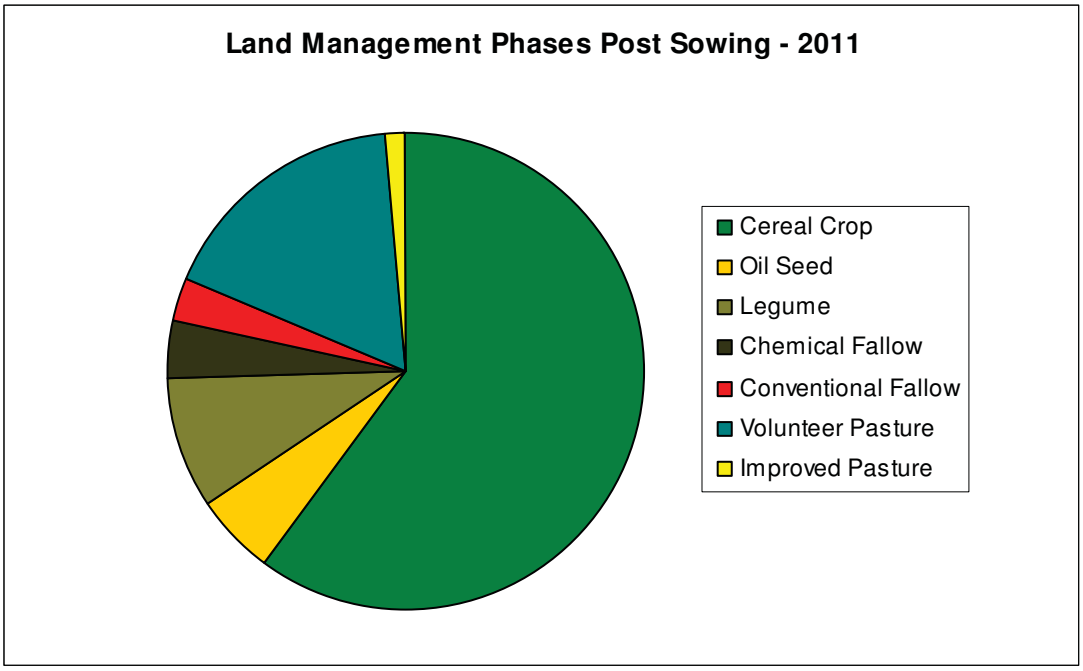

Figure 5: Percentage of the sites under different land management phases, observed during the post sowing 2011 survey.

Of the cropped sites surveyed, 17.19% were being managed with conventional farming practices and 57.96% were being managed with no-till/minimal till (Figure 6, Table 7).

Table 7: Percentage and number of cropped sites in conventional and no-till/minimal farming land management practice.

Land System	Observed Crops Sown to Conventional Farming	Observed Crops Sown to No-Till/Minimal Till Farming
Boigbeat	0% (0)	100% (10)
Central Mallee	10.38% (8)	58.44% (45)
Culgoa	29.41% (5)	41.17% (7)
Hopetoun	13.04% (3)	60.86% (15)
Millewa	30.00% (6)	45.00% (9)
Tempy	50.00% (5)	20.00% (4)
Total	**17.19% (27)**	**57.32% (90)**

One land system recorded 100% of its site in a no-till/minimal till land management practise in the post sowing 2011 survey. Ninety (57.32%) sites were observed as being managed in a no-till/minimal till management practice and twenty-seven (17.19%) sites were observed as being managed in conventional farming practice at the post sowing 2011 survey.

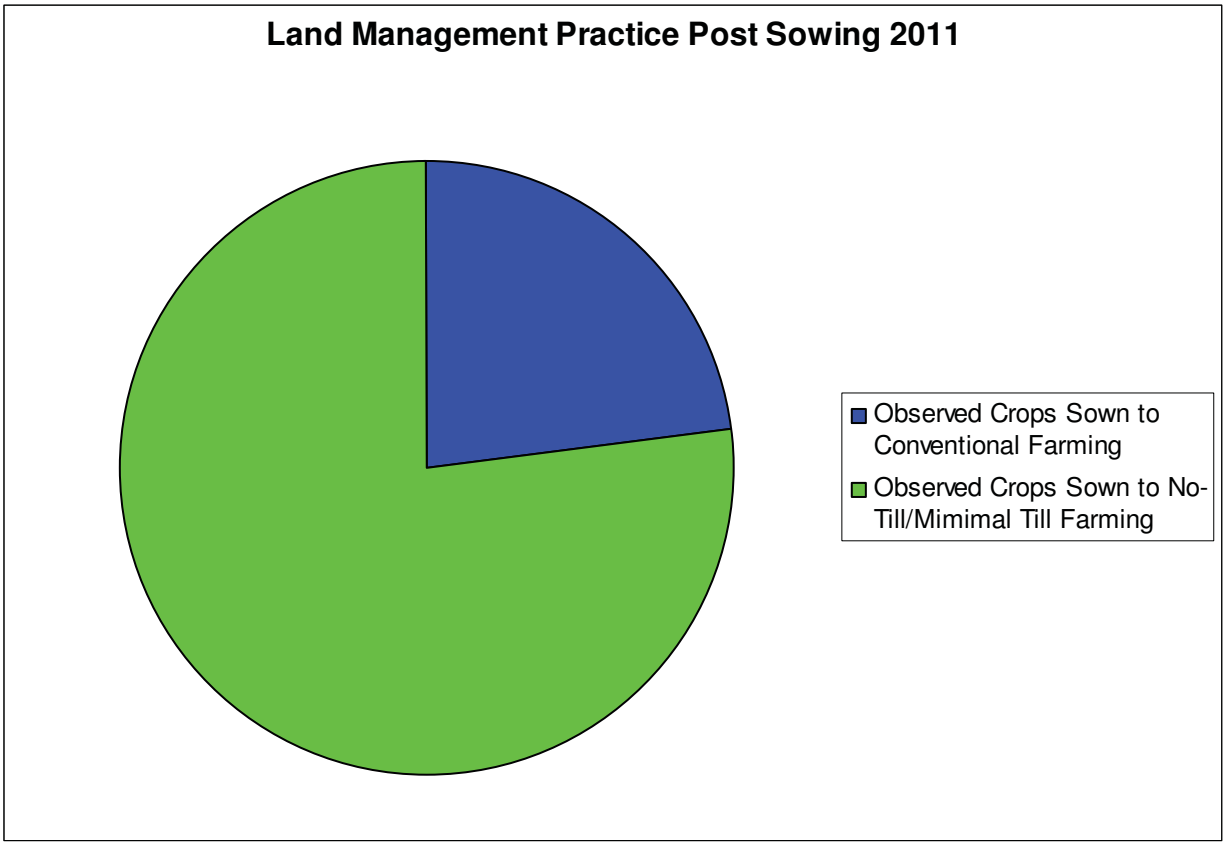

Figure 6: Percent of cropped sites observed with conventional and no-till/minimal till farm practices recorded during the post sowing survey 2011.

During the post sowing 2011 survey, 9.9% of sites (16 sites) were observed to have livestock present. Fifteen sites had sheep present with one site having cattle present. 87.6% recorded absence of stock (Figure 7).

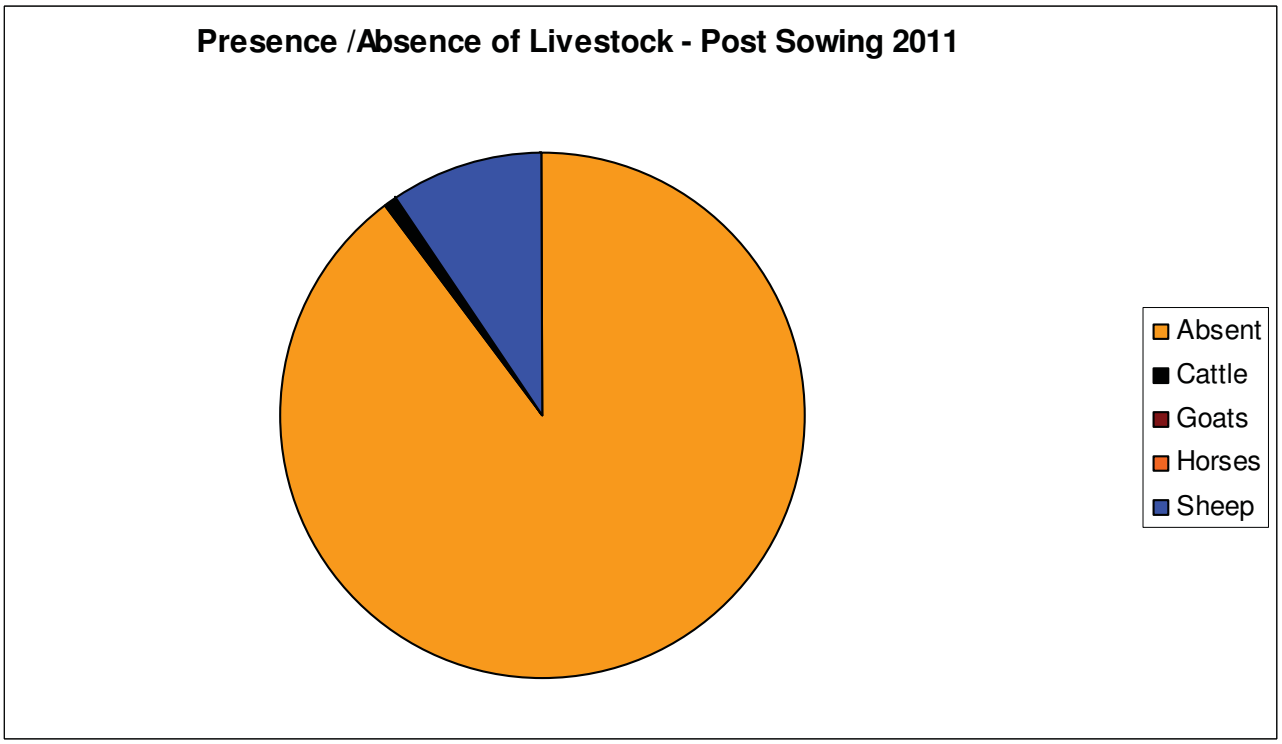

Figure 7: Percentage of sites with livestock absent/present, observed during the post sowing 2011 survey.

Vegetation Measurements

The post sowing 2011 survey reported that 26.12 % of the surveyed sites had greater than 70% vegetation cover and 22.93% had coverage from 50 - 70 % rating these sites at low risk of erosion. Eight (5.09%) survey sites reported less than 10% coverage, rating these sites at high risk of erosion (Figure 8 and Table 8).

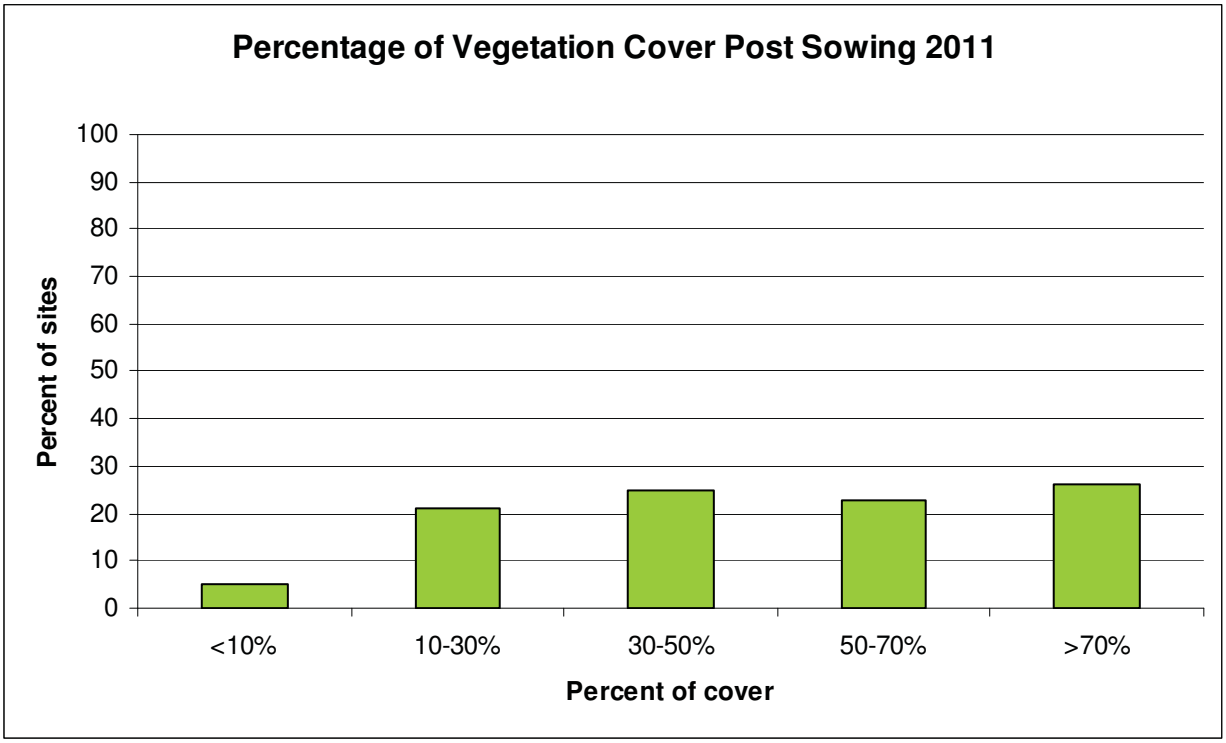

Figure 8: Percentage of vegetation cover at sites surveyed for the Mallee Soil Erosion and Land Management Survey, results from the post sowing 2011.

Table 8: The percent (and number) of sites by land system recorded vegetation cover during the post sowing 2011 survey.

LandSystem	<10%	10-30%	30-50%	50-70%	>70%
Boigbeat	0.0% (0)	40.0% (4)	20.0% (2)	30.0% (3)	10.0% (1)
Central Mallee	1.29% (1)	15.58% (12)	25.97% (20)	33.76% (26)	23.37% (18)
Culgoa	17.64% (3)	35.29% (6)	23.52% (4)	5.88% (1)	17.64% (3)
Hopetoun	4.3% (1)	4.3% (1)	8.7% (2)	13.0% (3)	69.6% (16)
Millewa	15.0% (3)	35.0% (7)	35.0% (7)	10.0% (2)	5.0% (1)
Tempy	0.0% (0)	30.0% (3)	40.0% (4)	10.0% (1)	20.0% (2)
Total	**5.09 (8)**	**21.02 (33)**	**24.84 (39)**	**22.93 (36)**	**26.12(41)**

Erosion Risk

Q Value

Table 9: The percentage (and number) of sites with low, medium and high erosion risk calculated using the formula derived by Leys (Leys et al, 2002) NB. Data calculated within the data base on 157 active sites.

Land System	Low	Medium	High
Boigbeat	100% (10)	0% (0)	0% (0)
Central Mallee	100% (77)	0% (0)	0% (0)
Culgoa	100% (17)	0% (0)	0% (0)
Hopetoun	95.66% (22)	0% (0)	4.34% (1)
Millewa	65.00% (13)	35.00% (7)	0% (0)
Tempy	90.00% (9)	10.00% (1)	0% (0)
Total	**94.26% (148)**	**5.09% (8)**	**0.63% (1)**

Soil erosion risk matrix

Table 10: The percentage (and number) of sites with low, medium and high erosion risk estimated using the soil erosion risk matrix (Table 5). NB. Manual calculations based on 157 active sites.

Land System	Low	Medium	High
Boigbeat	100% (10)	0% (0)	0% (0)
Central Mallee	98.70% (76)	1.30% (1)	0% (0)
Culgoa	82.35% (14)	17.64% (3)	0% (0)
Hopetoun	91.30% (21)	4.34% (1)	4.34% (1)
Millewa	45.00% (9)	35.00% (7)	20.00% (4)
Tempy	80.00% (8)	20.00% (2)	0% (0)
Total	**87.89% (138)**	**8.92% (14)**	**3.19% (5)**

Assessment of soil stability

Table 11: The percentage (and number) of sites with a detachment rating of 1, 2 or 3. NB. Manual calculations based on 157 active sites.

Land System	1	2	3
Boigbeat	90.00% (9)	10.00% (1)	0% (0)
Central Mallee	85.71% (66)	64.70% (11)	0% (0)
Culgoa	64.70% (11)	23.52% (4)	11.76% (2)
Hopetoun	78.26% (18)	13.04% (3)	8.69% (2)
Millewa	60.00% (12)	25.00% (5)	15.00 % (3)
Tempy	30.00% (3)	40.00% (4)	**30.00% (3)**
Total	**75.79% (119)**	**17.84% (28)**	**6.37% (10)**

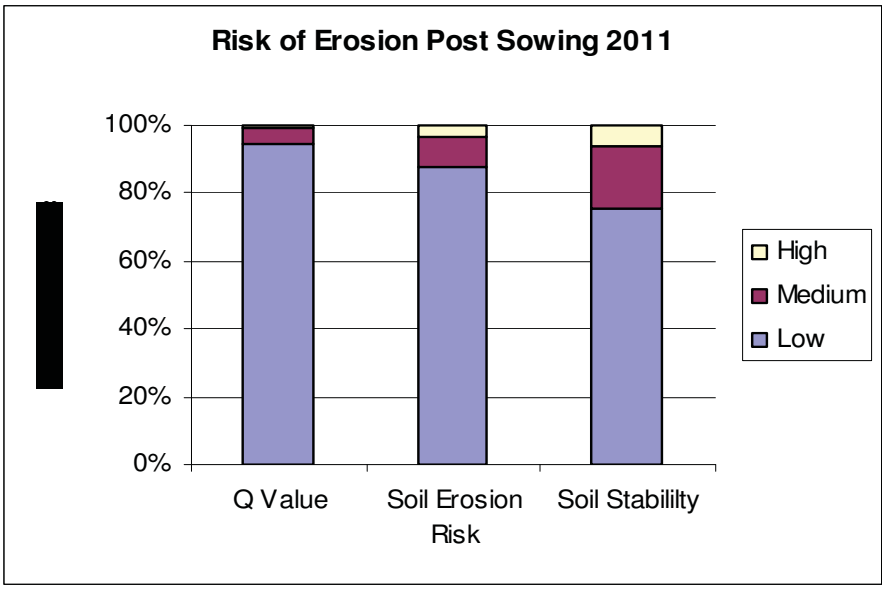

Figure 9: Risk of erosion recorded from the post sowing 2011 Mallee soil erosion and land management survey.

The results from the three different methods of erosion risk recorded similar results. Q value (Table 9), soil erosion risk matrix (Table 10) and assessment of soil stability (Table 11) results were based on 157 recorded active sites in the data base.

Results from Q value (Table 10) indicated that 94.26% (148 sites) were at a low risk of erosion and recorded only one site (0.63%) with a high risk of erosion. Soil erosion risk matrix (Table 10) indicated 87.89% (138 sites) were at a low risk of erosion, with 8.92% (14 sites) is at medium risk and 3.19% (5 sites) of the sites at a high risk of erosion. Assessment of soil stability (Table 11) recorded 75.79% (119 sites) were at a low risk of erosion and 17.83% (28 sites) were at a medium risk and 6.36% (10 sites) at high risk of erosion.

Results from the Q value and soil erosion matrix were more closely aligned than the results from the assessment of soil stability. Both the Q value and soil erosion matrix methods are based on actual measurements of soil dry aggregate and vegetation cover whereas the soil stability measurement is a visual record with the potential for greater variation in the results making it a less accurate assessment.

Conclusion

During the post sowing survey 2011:

- Soil erosion soil matrix resulted in 87.89% of sites with a low risk of erosion.
- 49% of sites had greater than 50% vegetation coverage, rating these sites as a low risk of erosion.
- 74.5% of the sites were sown to crop, with 3.8% in a chemical fallow management and 3.2% in conventional fallow. Sites under pasture management were 18.5%.
- 17.19% of the cropped sites surveyed were being managed with conventional farming practices and 57.32% were being managed with no-till/minimal till.

Recommendations

- Continue collaborating with NSW, SA and WA to continue to develop soil erosion monitoring protocols, in particular to develop methods to measure the risk of erosion.

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