Managing soil cover in variable seasons

MIXED FARMING MASTERCLASS – LOCK, 12th September 2019

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1. Erosion Risk on Eyre Peninsula

Of the approximately 2.7 million hectares of cleared agricultural land on Eyre Peninsula about 2.4 million hectares (88%) are inherently susceptible to wind erosion (Figure 1) due to sandy textured soils with around 690,000 hectares (25%) that are inherently susceptible to water erosion, on sloping, hilly land on lower and eastern EP (Forward 2019) (Figure 1).

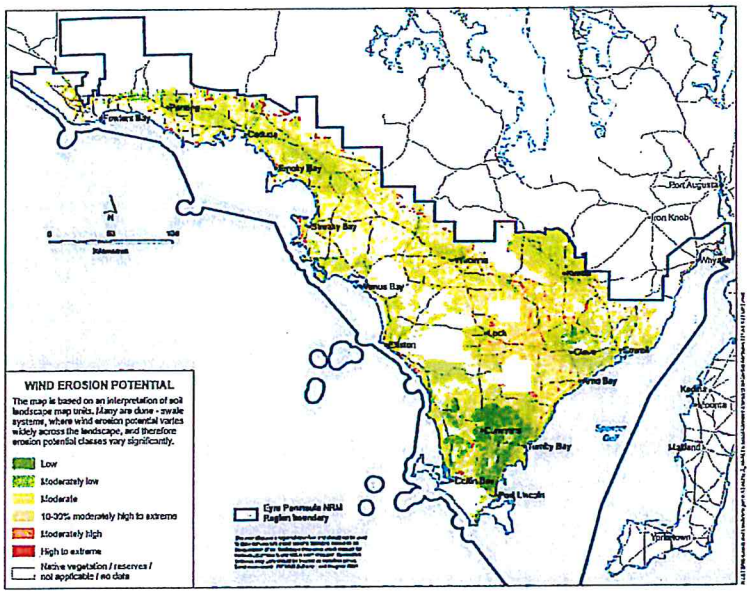


Figure 1. Inherent susceptibility of cleared agricultural land to wind erosion in the EP NRM Region (Source: Forward, 2019).

Due to changes in farming practices (including adoption of no till, stubble retention and improved grazing management) the frequency and severity of soil erosion has reduced in recent years with monitoring of paddock surface cover measuring a decline in the number of days that soils in the region are at risk of erosion from 69 in 2000 to 17 in 2019 (Figure 2).

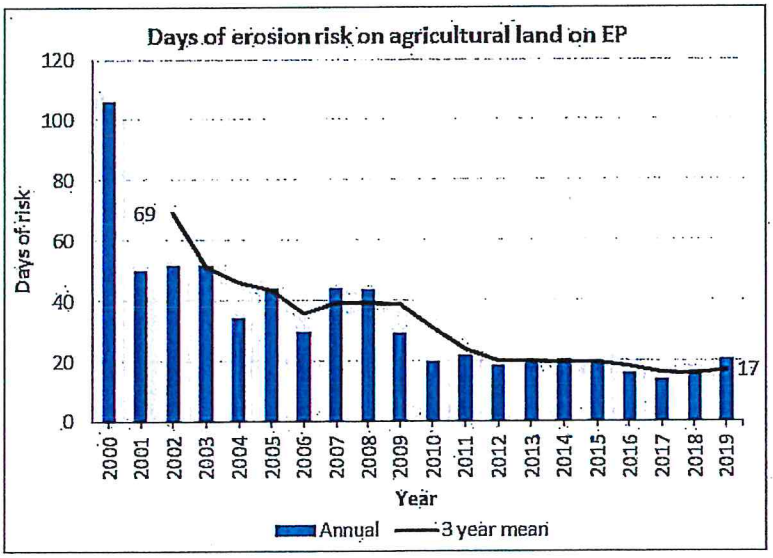


Figure 2. Days of erosion risk (annual and 3 year rolling mean) on agricultural land in the EP region from 2000 to 2019, based on field surveys (Source: Forward, 2019).

However, dry seasonal conditions where plant growth is inadequate to provide sufficient groundcover can increase the risk of erosion and keeping the soil surface covered and maintaining soils in a cohesive or undisturbed condition, particularly for as long as possible are the key factors in reducing the risk of erosion. On Eyre Peninsula surface cover levels tend to be highest in spring with soil exposure increasing from late summer until autumn sowing.

2. Wind erosion – Understanding the issue.

Surface soil texture is key in determining the inherent potential for soils to erode. Sandy soils are made up of singular inert particles making it difficult for them to form and maintain aggregation. As such these individual particles are vulnerable to becoming detached and transported by wind. Erosion of 1 mm of soil from the soil

surface can equate to losses of 10-12 tonnes of soil per hectare. As well as the soil loss there can be significant loss of nutrients and organic matter which are drivers of crop and pasture productivity.

Whilst clay particles are much smaller than sands, and as individual particles can easily be picked up and transported by wind, there is a tendency for these particles to bind together (by ionic and electromagnetic bonds) forming heavier aggregates (soil 'clods') which are less vulnerable to being detached and transported by wind. Additionally clay soils can store large amounts of water resulting in heavier clods which are less likely to be picked up by wind

3. Managing the risk of erosion.

3.1 *Importance of surface cover for erosion protection.*

Whilst soil texture influences inherent soil erodibility, the risk of erosion on a soil is significantly increased by soil disturbance and low surface cover levels due to removal of vegetation, tillage and overgrazing. Active soil erosion is hard to control therefore paddocks should be managed to reduce the risk of erosion by maintaining adequate surface cover. Surface cover (including stubbles, actively growing crops, pastures and weed, rocks and soil clods) provide protection from the erosive forces of wind and water by reducing the impact of raindrops hitting the soil, slowing or deflecting wind away from the soil surface and helping to trap soil particles.

3.2 *How much surface cover is required*

Surface cover forms a barrier which provides protection from the erosive force of the wind for a distance of up to 10 times its height (Figure 3)

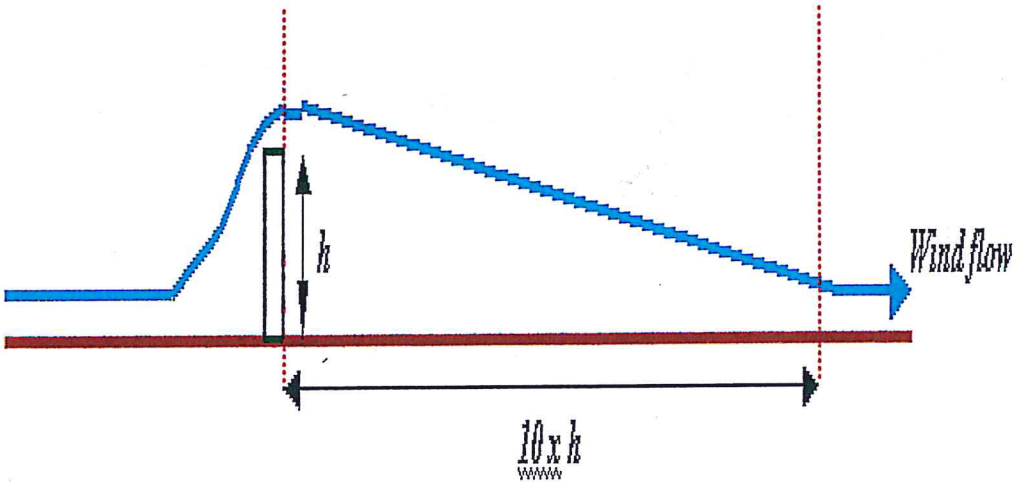


Figure 3. Effect of surface cover deflecting the wind upward protecting the soil surface from the erosive force of wind for a distance of up to 10 times its height.

Results from work undertaken in the Mid North of South Australia showed, that where stubbles were of moderate to high density there was a consistent relationship between stubble height and wind speed close to the soil surface. When stubbles were slashed near ground level, wind speed 20 cm above ground level was still around 2/3 of that 2 m above ground level, however retaining stubble at a height of 35 cm reduced the 20 cm wind speed to just 20% of that 2 m above the ground (Mudge 2011).

This highlights the importance of retaining well anchored standing stubble for managing wind erosion. A further observation of this study was that having crop rows aligned perpendicular to the direction of the stronger (more erosive) wind events for the district, not necessarily the prevailing wind direction, might help to reduce the wind erosion risk.

4. Minimum surface cover needed to protect soil from wind and water erosion

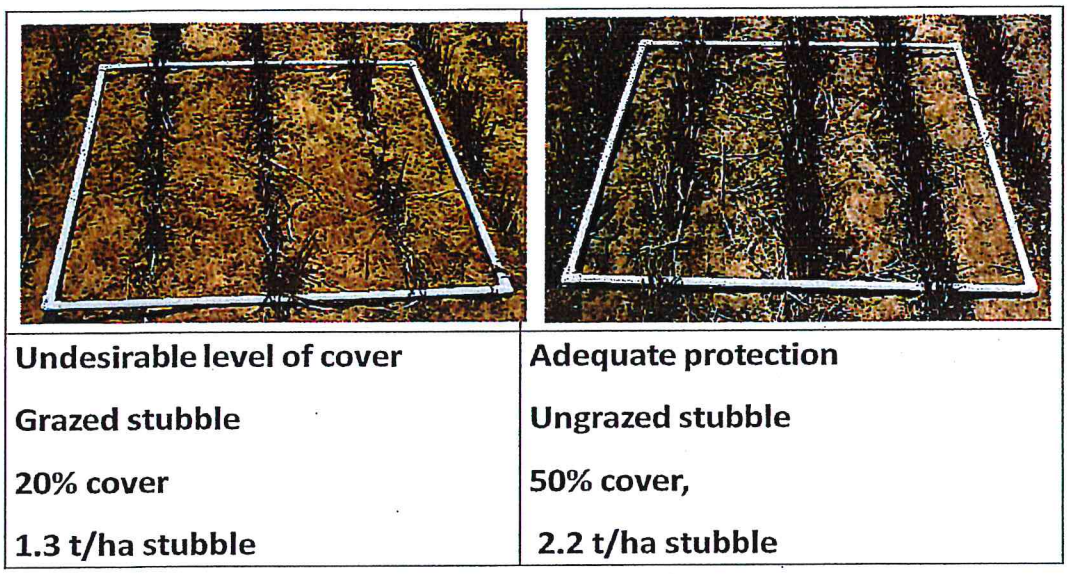
DWLBC (2008) provides a guide to minimum and desirable cover levels developed from simulated rainfall and wind tunnel studies (Table 1). However, there is a qualifying statements suggesting that although these levels will provide soil protection under most conditions they will not necessarily prevent erosion occurring in particularly intense rainfall storms or very windy conditions:

Table 1. Desired surface cover to minimise the risk of erosion on different soil types

	Minimum cover		Desirable cover	
	%	t/ha	%	t/ha
Wind erosion				
- loam	15	0.5	35	1.0
- sandy loam	20	0.6	50	1.5
- sand	50	1.5	70	2.5
Water erosion				
- level land	60	2.0	75	3.0
- sloping land	75	3.0	85	4.0

Source: DWLBC, 2008

As the mechanism for water erosion relies on raindrop impact dislodging soil particle a higher percentage of the soil surface area is required to be covered to provide protection against erosion (60 – 75%), Wind erosion risk is driven more by the height and density of the surface cover. The minimum surface cover levels for protection against wind erosion are in the order of 15 – 50% depending on soil texture, with desirable surface cover levels of 50% for sandy loams and 70% for sands (DWLBC 2008).



Undesirable level of cover	Adequate protection
Grazed stubble	Ungrazed stubble
20% cover	50% cover,
1.3 t/ha stubble	2.2 t/ha stubble

Figure 4. Stubble residue photographs comparing sandy sites with and without adequate surface cover for wind erosion protection.

5. Methods for assessing surface cover levels

There are several techniques that can be used to assess the level of surface cover in a paddock. These include visual assessments using established surface cover ratings or photo standards, estimates from grain harvest yield and measurements. A number of these are described in the DWLBC Factsheet (#89) *'Surface cover for protection against wind and water erosion'* and are summarised below.

5.1 Summary of surface cover assessment methods.

5.1.1 Estimates from standard photographs - Oblique and vertical photographs of various amounts of cereal stubble can be used as a guide to estimate cover, including cover levels in pastures. Views are provided for 15, 35, 60, 75 and 85% cover and correspond to 0.5, 1.0, 2.0, 3.0 and 4.0 t/ha of wheat stubble respectively.

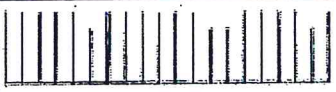
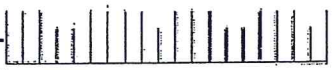
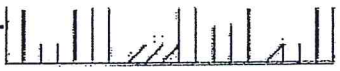
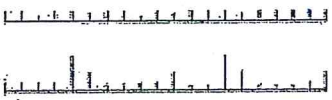
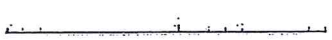
5.1.2 Estimates of harvest yield – stubble residues remaining after harvest is in the order of 1.2 t/ha in high yielding crops to 1.5 t/ha in lower yielding crops or tall growing varieties.

5.1.3 Measure of dry weight of cover – collect all surface residues within a 1 m2 are and weigh them. Convert this weight to obtain an estimate of dry matter in t/ha (100 g/m2 is equal to 1 t/ha)

5.1.4. Percentage of bare ground (spot readings) – take spot reading at 100 points at random along a transect/or within a grid recording whether the point falls on bare soil or cover (Figure 5). The proportion of samples which fall on cover material gives the average surface cover for the area.

5.2 *Erosion protection field survey method.*

Erosion protection field surveys are conducted throughout the state at key times during the seasonal growth cycles of annual crops and pastures each year. These use a simple visual assessment of key groundcover, surface looseness and soil and landscape parameters at predetermined sites to generate an annual profile of erosion protection. The full methodology is available at;
https://www.environment.sa.gov.au/topics/Science/Science_research/Monitoring_evaluation_analysis/monitoring/erosion-protection-field-surveys

Rating	Height (wind erosion)	Cover % (water erosion)	
1	Residues 40cm or higher.	75 to 100%	
	Bulk: Very high level of plant matter Anchorage: Majority of cover is anchored and stable, not (easily washed or blown away).		
2	Residues between 10cm and 40cm.	Even coverage of approx. 75 to 100%	
	Bulk: high amount of plant matter, most of which is standing Anchorage: Majority of cover is anchored.		
3	Residue height variable from less than 10cm to 40cm.	More variable cover of approx. 75 to 100%	
	Bulk: moderate to high but more variable across the paddock Anchorage: Cover often slightly flattened and damaged		
4	Residues 2cm-10cm, but of moderate bulk. Residues a mixture of upright and flattened.	50 to 75% cover, residue colour dominates	
	Bulk: Moderate Anchorage: Majority of residues are anchored, although often flattened or damaged.		
5	2cms of relatively even but thin residue cover remain. or, cover variable from sparse 40cm to less than 2cm cover	50 to 75% cover, Residue colour still dominates	
	Bulk: Low, damaged through moderately heavy grazing or traffic by animals and/or machinery. Anchorage: majority of residues are anchored, most residues are damaged.		
6	**Height is variable and less than 10cm high to bare.**	**Soil colour dominates, 25 to 50% cover**	
	Bulk: Low amounts of plant material. Anchorage: some residues are anchored; most are damaged through grazing or cultivation.		
7	**Mostly bare although some residues can be seen. Grazed or cultivated virtually bare.**	**Soil colour dominates, 1 to 25% Scattered residues (and/or rocks) remain.**	
	Bulk: minimal amount of plant material. Anchorage: Any available residues, probably unanchored		
8	**Nil cover (bare)**	**0% cover**	
	Bulk: Nil Anchorage: Nil		

Most sites are considered to have adequate cover for erosion protection if cover is rated above 5 i.e. more than 2 cm of well anchored residue of moderate bulk.

Figure 5. Surface Cover Ratings for Erosion Protection Field Surveys. (Source: DEWNR 2011)

Definitions

- **Height**- Height of the surface cover. Used as the main factor to assess areas with inherent susceptibility to wind erosion
- **Cover %** - Percentage of the soil surface covered with plant material or stones etc. as viewed from the roadside, (oblique view). Used as the main factor to assess areas with inherent susceptibility to water erosion.
- **Bulk** - This is the overall amount of the surface cover material. For example, canola stubble vs. cereal stubble, both with similar height of cover will have different bulks.
- **Anchorage** - Anchorage is the surface cover attached to the soil (e.g. Undisturbed plant crowns) or is it detached (unanchored) by cultivation, grazing etc., and likely to blow or wash away.

6. Practices to Maintain and Improve Surface Cover Levels

6.1 Maintaining cover levels over summer

Maintaining adequate cover on a paddock in a dry season can be challenging, however once a paddock is bare there are few options to wind erosion until rainfall is received to germinate plants and stimulate growth. On vulnerable sites such as sandy soils, exposed hills, grain legume stubbles, and soil disturbed by livestock or cultivation or if grasses have been chemically removed extra care is required to protect land from erosion. On these sites land managers should avoid practices which reduce stubble height or root anchorage. Sites with grain legume stubbles can be particularly vulnerable as residues tend to break easily and blow away. Canola stubble whilst generally well anchored and tall can be less dense and offer less protection than cereal stubbles.

On wind erosion prone soils surface cover should be standing and well anchored to reduce wind speeds close to the soil surface. On water erosion prone sites the stubble should be flattened, to covering as much area of the soil surface as possible. Vulnerable areas should be protected from traffic by livestock or machinery, to reduce disturbing the surface soil and any protective crust that may have been form or loosening the crowns of anchored plant residues. Livestock should be kept away from these areas either by removing them from the paddock before surface cover falls below the critical levels or isolating access to these areas and controlling grazing on the rest of the paddock using temporary fencing.

It can also be useful to move high traffic areas such as gates and watering points to heavier ground to protect the vulnerable areas of the paddock. It is worth considering that over-grazing paddocks can also have a number of impacts including;

- Deterioration of stock health where pasture is low.
- Poor regeneration of perennial pastures in following years
- Colonisation of bare areas by weeds

6.2 Things to consider for remediating eroded areas/planning sowing the year after erosion has taken place.

Where soil erosion has taken place there are a few things that should be considered before deciding on what action to take these include;

- Inspect the area which has been subject to erosion - Sandy soils can develop an "armouring" following wind erosion and if the crowns of the plants are still intact or the surface is crusted tillage might destroy soil aggregates doing more damage than good.
- "Doing nothing" is an option if; a surface crust has developed, windy weather has abated, and it is likely that sufficient rains to stimulate plant growth will fall within a few weeks.
- Erosion might have resulted in loss of nutrition and organic matter, which is important for nutrient cycling, it is worth taking a soil test to confirm the nutritional status of the area and plan to increase fertiliser and seed rates at seeding to ensure good crop establishment.
- On sandy soils, particularly non-wetting sands, double sowing at offset angles can help to improve crop establishment and surface cover where there is not residual stubbles providing protection from erosion.
- If possible sow across the direction of the most damaging winds.
- Modification of sandy soils by clayspreading, delving and incorporation of amendments where appropriate can be useful to overcome some of the constraints on sandy soils which limit surface cover and production including non-wetting and low soil fertility.

7. References

Forward, G. (2019). 'Progress report on soil erosion protection in the Eyre Peninsula NRM Region', DEW. July 2019

Forward, G. (2011) 'Soil erosion protection field survey manual; Agricultural Cropping Districts', DEWNR May 2011.

Gale, G. (2008) 'Surface cover for protection against wind and water erosion', Factsheet 89, DWLBC

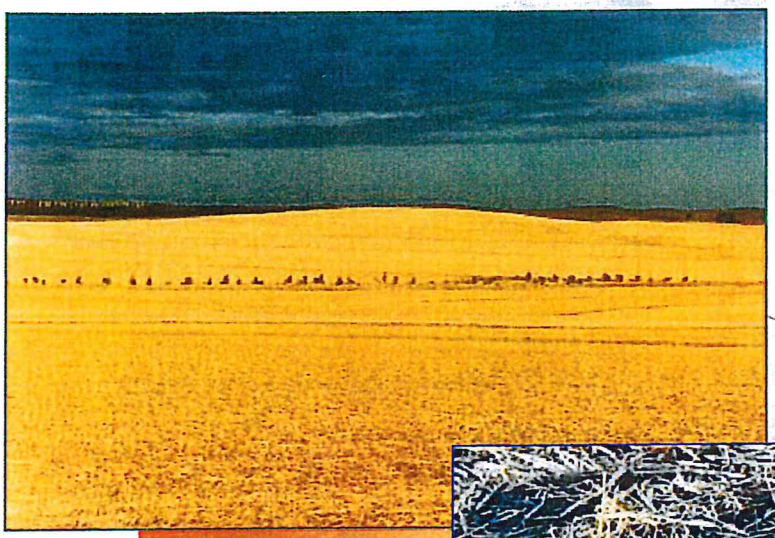
Mudge, B (2011) 'Effect of Stubble Height on Wind Speed' Northern and Yorke NRM, June 2011.

Fact Sheet

89

2001 fact sheet

Surface cover for protection against wind and water erosion



Assessing and maintaining soil surface cover are important for managing soil erosion risk on South Australian agricultural lands

Government of South Australia
Department of Water, Land and Biodiversity Conservation

Surface cover for protection against wind and water erosion

Fact sheet 89

Erosion risk is reduced by keeping a sufficient amount of crop or pasture residue on the soil surface. Residues help reduce the impact of raindrops hitting the soil, slow or deflect wind away from the soil surface and help trap or bind soil particles so they are less easily blown or washed away. The area of soil covered is more important than the total weight of residue. The amount of surface cover required depends on a number of factors including soil type and the degree of soil disturbance. Insufficient cover can result in serious erosion, even in moderate wind or rainstorm events.

This fact sheet describes the minimum surface cover levels needed to significantly reduce erosion risk, details some of the methods of assessing soil surface cover in broadacre farming, and discusses methods to reduce surface cover losses.

Wind erosion

Wind erosion can be a major problem in lower rainfall areas (250 to 400 mm a year) especially on sand and sandy loam soils. Other soils and higher rainfall areas can also suffer from wind damage when soils are bare and in a very loose or disturbed condition. Minimum cover levels range from 15% of total surface area on loams to 50% on sands (see Table 1). In general, more cover is needed for sandy soils, exposed hills and soil disturbed by livestock or cultivation.

Water erosion

Water erosion is more prevalent in higher rainfall areas (more than 400 mm a year), especially on slopes, poorly structured soils and soils in a loose (eg. cultivated) condition. Minimum cover levels range from 60% of total surface area on level land to 75% on cropping land with a slope (see Table 1). Steeper slopes, poorly structured soils or soils disturbed by grazing or cultivation require more cover. To reduce the damaging impact of raindrops on soil structure and to optimise rainfall infiltration, cover should be at least 75%.

Minimum surface cover needed to protect soil from wind and water erosion

A guide to minimum and desirable cover levels has been developed from simulated rainfall and wind tunnel studies. The cover levels are shown in Table 1. These levels will not prevent erosion occurring in intense rainfall storms or very windy conditions but will provide soil protection under most conditions.

Table 1. Surface cover needed to protect soil from wind and water erosion

	Minimum cover		Desirable cover	
	%	t/ha	%	t/ha
Wind erosion				
- loam	15	0.5	35	1.0
- sandy loam	20	0.6	50	1.5
- sand	50	1.5	70	2.5
Water erosion				
- level land	60	2.0	75	3.0
- sloping land	75	3.0	85	4.0

(Equivalent quantity of wheat stubble is given in tonnes/hectare. Wind erosion data from experiments in SA's northern Murray Mallee. Water erosion data from work in SA's Lower North. Figures are approximate).

Type of surface cover required

It is important that some cover is anchored in the soil to prevent loose material blowing or washing away, and this cover should be either standing for wind erosion protection or flattened (covering as much of the soil surface as possible) for water erosion. Chaff and other fine materials provide little protection, and are readily blown away or buried by livestock and cultivation. Grain legume stubbles are easily broken off and blown away and offer poor protection.

Methods for assessing cover levels

There are several techniques that can be used to assess the level of surface cover in a paddock.

While no method is perfect or foolproof, these techniques are still useful tools in managing surface cover to reduce the risk of erosion.

Surface cover photographs

Photographs of various amounts of cereal stubble can be used as a guide to estimate cover, including cover levels in pastures. Oblique and vertical views are provided for 15, 35, 60, 75 and 85% cover. These correspond to 0.5, 1.0, 2.0, 3.0 and 4.0 t/ha of wheat stubble respectively. (see Photo Estimates)

Estimates from harvest yield

The amount of stubble remaining after harvest can be estimated from grain yield. In high-yielding cereal crops, multiply yield by 1.2. For crops with low yields (due to low rainfall or poor finish), and older varieties with tall straw, multiply grain yield by 1.5 (see Figure 1). These amounts do not include fragments of leaves and chaff, which provide little soil protection.

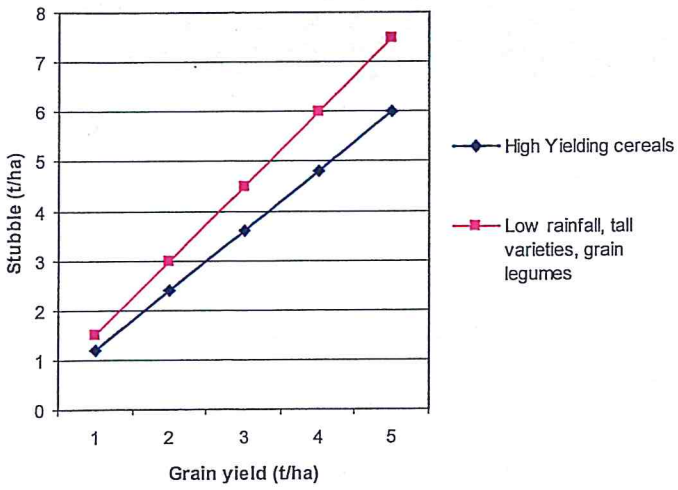


Figure 1. Approximate relationship between grain yield and stubble remaining after harvest

Figure 2 shows the relationship between percentage cover and weight of slashed wheat stubble. The surface cover percentage could be lower if more stubble is standing or present in longer lengths.

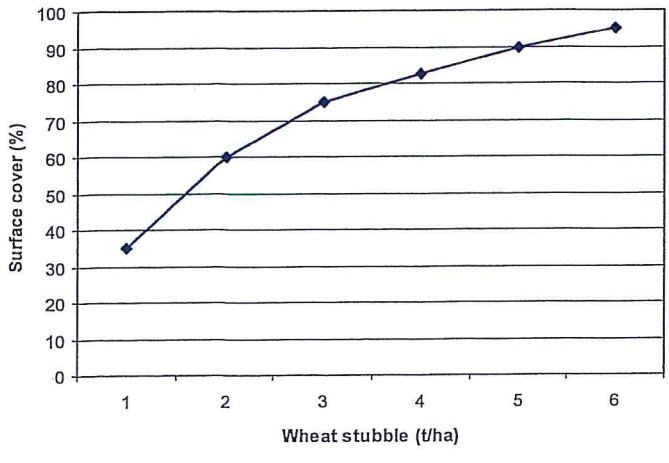


Figure 2. Relationship between surface cover and wheat stubble weight (Stubble has been slashed and evenly spread, with root and crowns anchored in the soil)

Measurement

An estimate of weight of cover can be made by placing a 1m² quadrat on the ground, collecting all of the surface residues within the quadrat and weighing them. Convert the weight to obtain a t/ha estimate, that is, 100 g/m² equals 1 t/ha of residues. Figure 2 provides an estimate of the percentage surface cover this equates to. Figure 3 shows a 1m² quadrat with the surface cover removed.

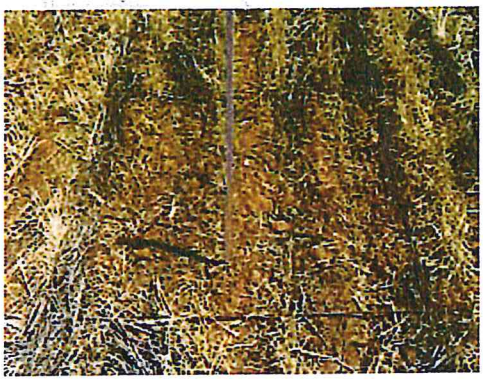


Figure 3. Surface cover removed from a one metre square quadrat

Percentage of bare ground (spot readings)

This method involves taking a number of spot readings of surface cover along a number of transects, that is, scoring what is at a random point at a certain number of paces. Each sampling point can be determined by placing the tip of a piece of wire on the ground and looking to see if it is on cover material or not. The proportion of sampled points that fall on cover material, determines the average surface cover of the area. Figure 4 shows an example of a score sheet used in the assessment. This method is described in detail in the fact sheet listed in the Further Reading section.

Location: Western block
Sampling Area: lambing paddock
Date: 24/5/07

Transect	Surface Cover	
	yes	no
1	𝍸 𝍸 𝍸 𝍸	𝍸
2	𝍸 𝍸 𝍸 𝍸 III	II
3	𝍸 𝍸 𝍸 𝍸 II	III
4	𝍸 𝍸 𝍸 𝍸	𝍸
TOTAL YES divided by TOTAL RECORDINGS = 85/100		
% COVER = 85%		

Figure 4. Example of scoring sheet for assessing percent bare or covered ground

Causes of cover loss

The amount of surface cover and the rate at which it is lost, will be influenced by a number of factors. These include:

Natural breakdown

Crop and pasture residues will break down naturally over time and reduce the amount of surface cover. Soil biota break down the organic materials and their level of activity depends on a number of factors such as number and type of biota, moisture, temperature and the composition of residues. Many microbes cannot feed on surface residues until the residues come into contact with the soil hence flattened stubble will often break down quicker than standing stubble. Natural breakdown will reduce cover levels by around 20% between harvest and the break of the next season.

Grazing

Stock consume residues and also trample and loosen them. Heavy grazing also pulverises dry soil, loosens its surface and increases the risk of erosion. Special care is needed on sandy soils, cultivated land, on grain legume stubbles, or if grasses have been removed or chemical-topped in the pasture. On sloping soils susceptible to water erosion, concentrated stock traffic (gateways, tracks etc) tends to break down soil structure, increasing the risk of erosion. Stock should be taken out of paddocks before surface cover falls below the critical level. Confining and feeding stock in a small area can protect paddock surface cover levels (Figure 5).

The preferential grazing patterns of livestock bare some areas such as sandhills and campsites while others remain well covered. Relocating watering points, fence positions or using electric fencing are ways to manage this problem.

Crusts that form on sandy soils after rain will help to protect the soil from wind, and are helpful if cover falls below required levels. Any soil disturbance including stock or vehicle traffic will destroy this crust.

Figure 5. Feedlotting stock to protect paddock surface cover levels

Tillage

Each tillage operation reduces the level of surface cover. The total reduction in surface cover depends on the number of tillage passes, including sowing, and the type of implement used. A guide to the amount of residue buried by various implements is shown in Table 2.

Reducing the number of tillage operations and using less aggressive tillage implements helps maintain surface cover. It will also reduce soil disturbance, another important factor in erosion risk. In sandy soils, blade ploughs, rod weeders or sweep shares on chisel ploughs leave the greatest amounts of cover. Disc implements bury a large amount of residue and completely loosen the soil. Prickle chains, while not removing large amounts of cover, significantly loosen the soil surface.

The root crowns of plants which help to stabilise sandy soils against wind are readily broken up by tillage operations.

Table 2. Burial of surface residue by various tillage implements

	Reduction of surface cover per working (%)
Prickle chain	5 to 10
Rod weeder	5 to 10
Blade plough	5 to 10
Seeder	
- narrow points	10 to 15
- full cultivation	20 to 30
Chisel plough	20 to 30
Combine	30 to 40
scarifier	30 to 40
Offset disc or disc plough	50 to 60

Burning

Burning residues leaves the soil exposed and susceptible to wind and water erosion. "Cold" burns, although intended to leave some cover, are difficult to manage to ensure they leave enough or evenly distributed cover.

Summary

Surface cover is vital in protecting soils from wind and water erosion. The amount of cover needed varies with the erosion risk.

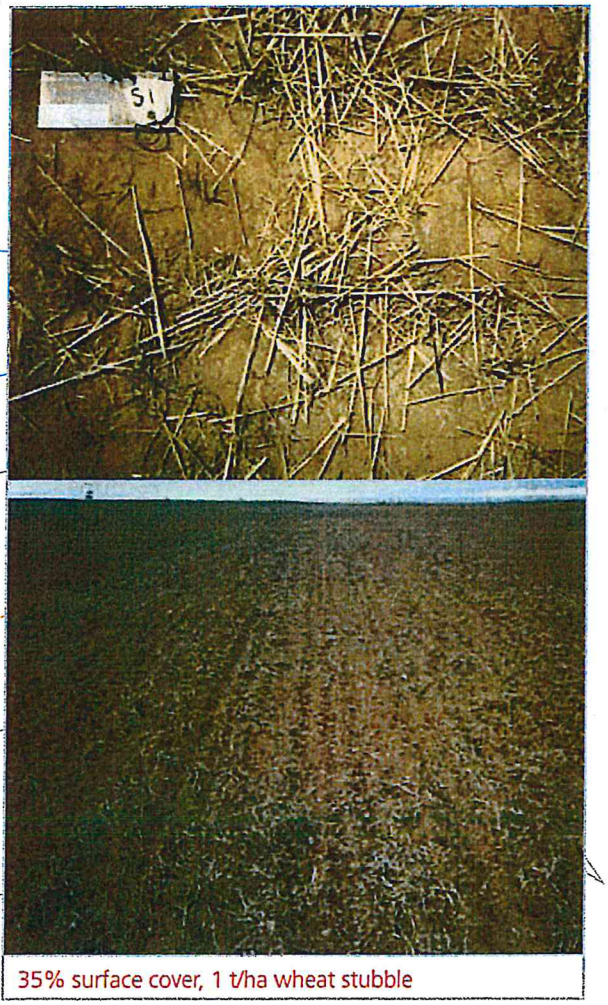
Management of crop and pasture residues must leave enough cover to protect the soil surface. Assessing and monitoring the amount and distribution of residues is important in their management.

Further Reading

Francis, AR and Payne, RA 2001, Field method for measuring soil surface cover.
PIRSA Fact Sheet No. 08/01

Photo Estimates

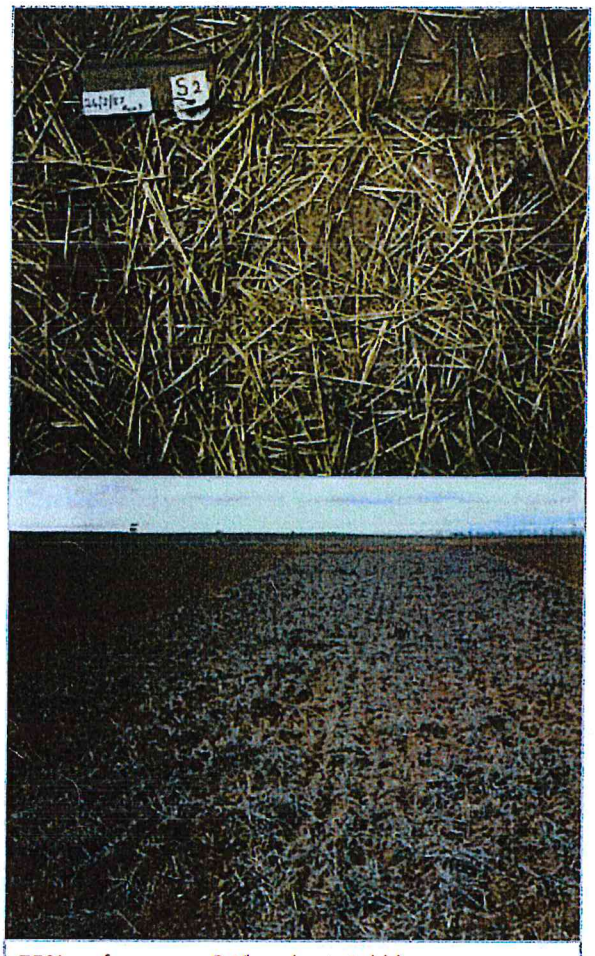
15 % surface cover, 0.5 t/ha wheat stubble



35% surface cover, 1 t/ha wheat stubble

60% surface cover, 2 t/ha wheat stubble

85% surface cover, 4 t/ha wheat stubble



75% surface cover, 3 t/ha wheat stubble

Where to get further information?

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Tel: 8303 9345
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