



PROGRAM A


→ **SPATIAL TECHNIQUES FOR GRASSLAND CURING ACROSS AUSTRALIA AND NEW ZEALAND**

Danielle Martin<sup>1,2</sup>, Ian Grant<sup>1</sup>, Simon Jones<sup>2</sup> and Stuart Anderson<sup>3</sup>

<sup>1</sup>Space Based Observations Section, Bureau of Meteorology, Melbourne.  
<sup>2</sup>School of Mathematical and Geospatial Sciences, Royal Melbourne Institute of Technology, Melbourne.  
<sup>3</sup>Ensis Forest Biosecurity and Protection, Scion, Christchurch, New Zealand.

Email: Danielle.Martin@bom.gov.au


   



PROGRAM A : Spatial techniques for grassland curing across Australia and New Zealand

→ **AIM**

To produce an enhanced satellite-based grassland curing index to estimate grassland curing robustly across Australia and New Zealand from vegetation indices.





## OUTLINE

1. **BACKGROUND**
  - a) Grassland Curing
  - b) Fuel Moisture Content
  - c) Vegetation Indices
2. **METHODS**
3. **PRELIMINARY RESULTS**
  - a) Relationships between field and satellite measurements
  - b) Spectral Signatures of Grasslands
  - c) Sample of Spatial Curing product
4. **CONCLUSIONS**



## BACKGROUND

### Fuel Moisture Content

FMC is the percentage of water in vegetation


$$\text{FMC (\%)} = \left( \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \right) \times 100$$

Fuel Moisture has a great impact on the drying of grass as it increases the specific heat and thermal conductivity of the grass, resulting in the need for more absorbed heat for the grass to reach ignition temperature (Garvey and Millie, 2001).

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→ **Grassland Curing**

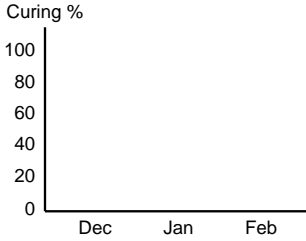


**Green**      **Cured**

Dec 16 2005      Feb 21 2006

60%                  82%

Curing %



Property	Vegetation Index	Past Studies that have utilised listed indices	
Active Growth	NDVI	(Allan et al., 2003)	Tropical Savannas (NT, Australia)
		(Cheng, 2006)	Rice fields (China)
		(Chuvieco et al., 2004)	Grasslands (Spain)
		(Dilley et al., 2004; Paltridge and Barber, 1988)	Grasslands (VIC, Australia)
		(Lu et al., 2003)	Woodlands/Grasslands (NSW, Australia)
		(Qi et al., 1994) (Huete, 1988)	Cotton fields (Arizona, USA)
Soil Correction	SRI	(Rahman et al., 2003)	Chaparral/Grasslands (California, USA)
		(Tucker, 1979)	Grasslands (USA)
		(Sims and Gamon, 2003)	Mixed species (California, USA)
Soil Correction	EVI	(Cheng, 2006)	Rice fields (China)
		SAVI (Huete, 1988)	Cotton fields/Grasslands (Arizona, USA)
		MSAVI (Qi et al., 1994)	Cotton fields (Arizona, USA)
		PVI (Huete et al., 1985)	Cotton fields/Grasslands (Arizona, USA)
			(Qi et al., 1994)
WDVI (Wiegand et al., 1991)	Crops (Texas)		
Atmospheric Correction	ARVI	(Qi et al., 1994)	Cotton fields (Arizona, USA)
		(Kaufman and Tanre, 1996)	Forests/Grasslands (France)
		SARVI (Huete et al., 1994)	Cotton fields/Grasslands (Arizona, USA)
		AFVI (Karnieli et al., 2001)	Burned Forests (Brazil)
Bulk Canopy Pigments/ Nitrogen	PRI	(Rahman et al., 2003)	Chaparral/Grasslands (California, USA)
		NDNI / NDLI (Serrano et al., 2002)	Chaparral (California, USA)
		CAI (Nagler et al., 2003)	Corn/Soybean fields (Japan)
Water Content	SRWI	(Zarco-Tejada et al., 2003)	Chaparral (California, USA)
		WBI (Rahman et al., 2003; Claudio et al., 2006)	Chaparral/Grasslands (California and San Diego, USA)
		NDWI (Gao, 1996)	Conifer forests (California and Colorado, USA)
		(Zarco-Tejada et al., 2003)	Chaparral (California, USA)



## NDVI

The range of available indices to assess curing in grasslands will depend on the spectral bands offered by the operational sensors.

One index produced from MODIS, which is suitable for curing assessment is the Normalised Difference Vegetation Index (NDVI)

$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$



## METHODS

### Field

#### Fuel Moisture Content:

- Destructive sampling

#### Grassland Curing:

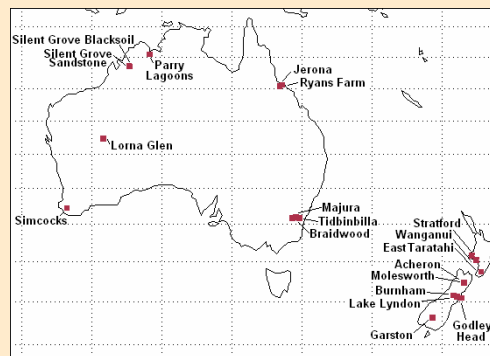
- Destructive sampling
- Visual observations
- Levy rod sampling

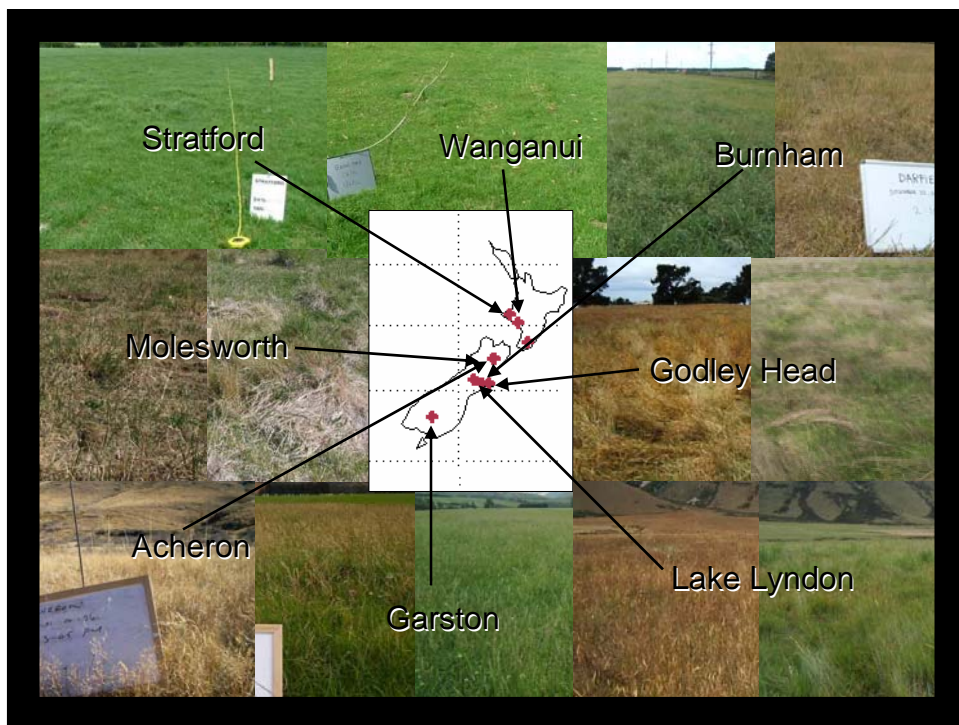
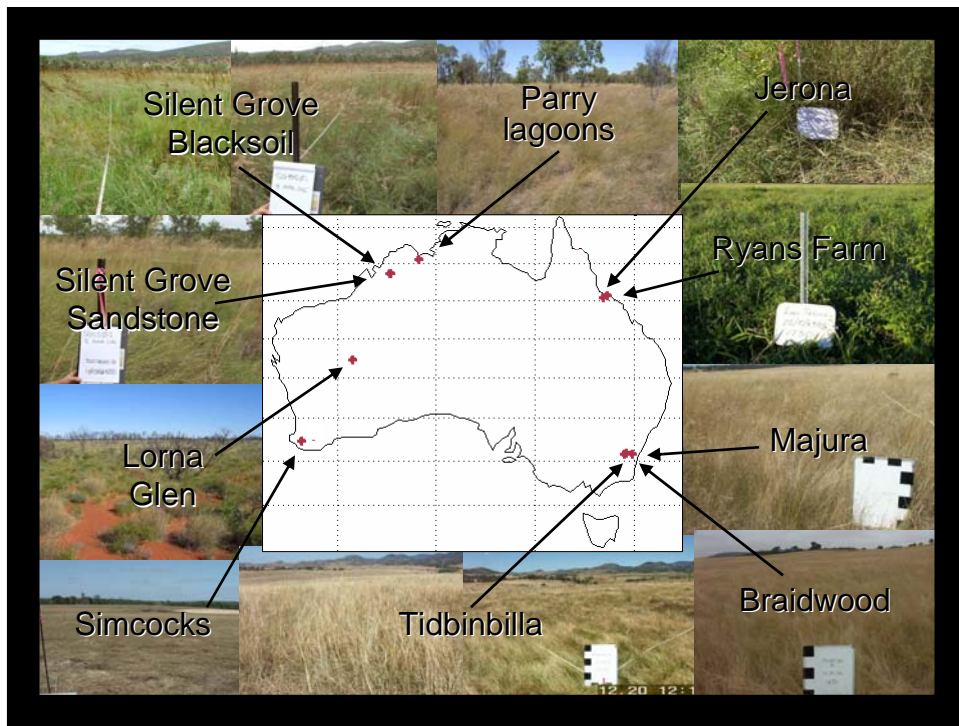
### Satellite

A MODIS product was collected from the Land Processes Distributed Active Archive Center website

(<http://edcdaac.usgs.gov/datapool/datapool.asp>):

MOD09A1: 8-day 500m surface reflectance







## Spatial Homogeneity

### Questions

- How representative is a field site of one MODIS pixel?
- How sensitive is the MODIS measurement to variations in location of the MODIS pixel?
- Are there any locations in the vicinity of the sampling we should avoid?

### Approach

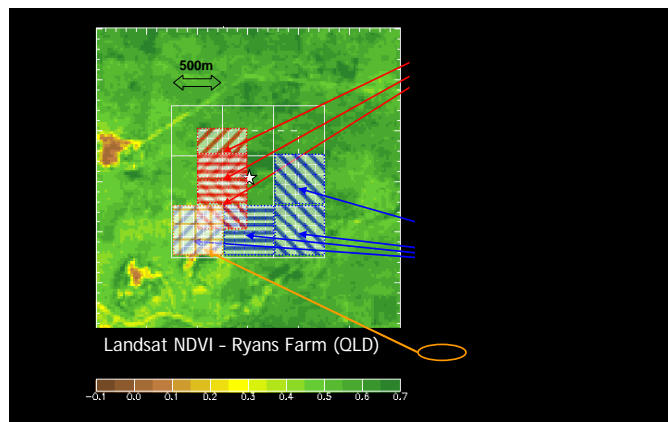
Study the impact of spatial homogeneity by analysing a 25m Landsat image of the site

Create NDVI images from the Red and NIR Landsat bands

- Measure the variation of 25m Landsat pixels:
- within one MODIS 500m pixel
  - between simulated MODIS 500m pixels

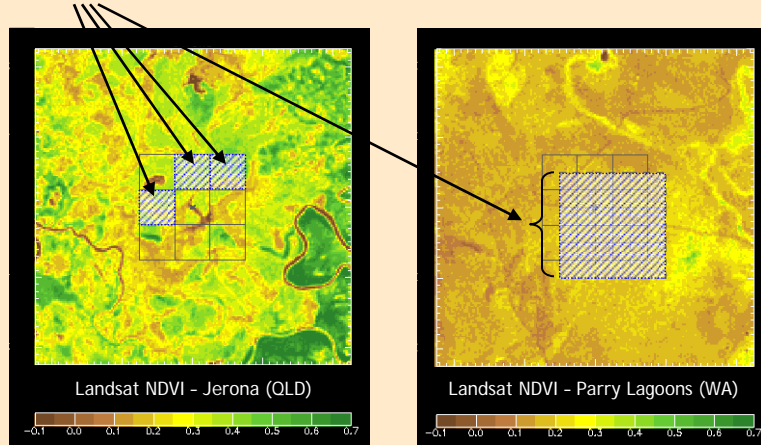
## Site Selection and Characterisation

Site should be representative of the surrounding area of 1500 by 1500m

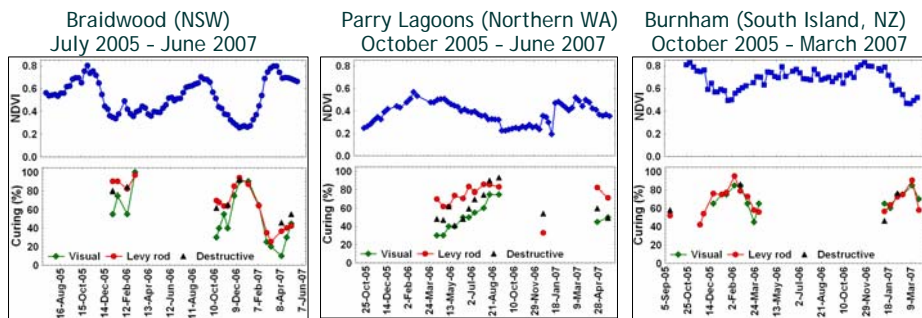


→ Site Selection and Characterisation (cont)

Selecting pixels

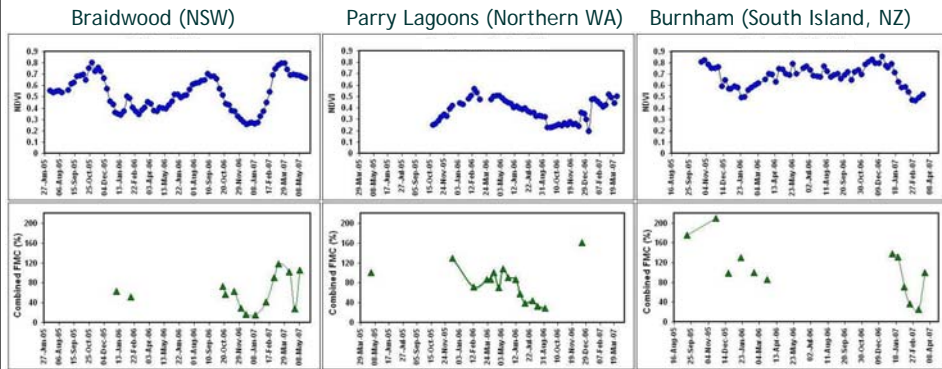


→ PRELIMINARY RESULTS  
Curing and NDVI Time-series



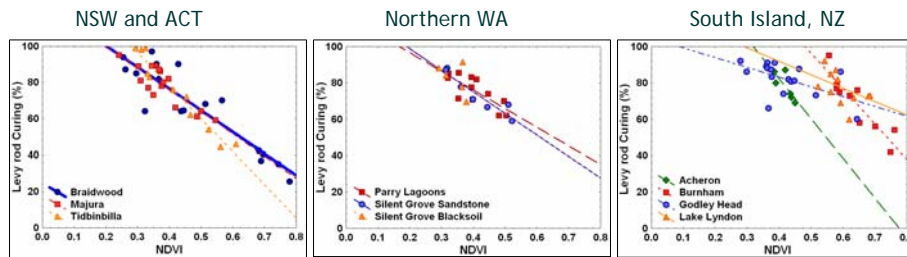
Time series of NDVI (top) and grassland curing (bottom) from three study sites: Braidwood (NSW), Parry Lagoons (Northern WA), and Burnham (NZ).

→ FMC and NDVI Time-series



Time series of NDVI (top) and combined fuel moisture content (bottom) from three study sites: Braidwood (NSW), Parry Lagoons (Northern WA), and Burnham (NZ).

→ Correlation between Levy rod Curing and NDVI

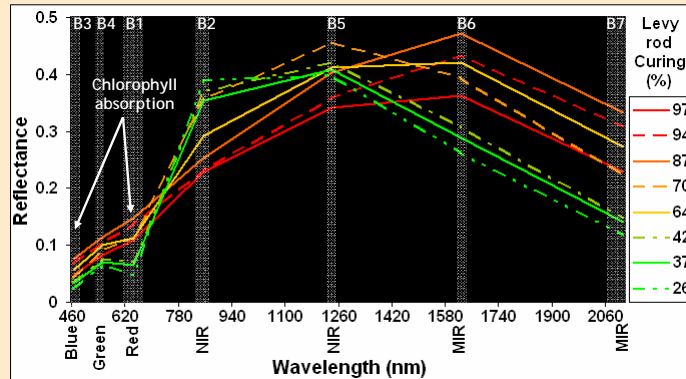


Correlations between NDVI and Levy rod Curing from: NSW/ACT (Braidwood, Majura, Tidbinbilla), Northern WA (Parry Lagoons, Silent Grove Sandstone, Silent Grove Blacksoil), and NZ (Acheron, Burnham, Godley Head, Lake Lyndon).





## Spectral Signatures of Grasslands

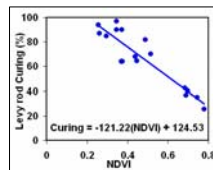


Each plot represents the reflectance value from a day of known curing value (at Braidwood), across MODIS's seven bands. Eg. The plot "70" represents the spectral signature from the 16th of October 2006, when (Levy rod) curing was 70%



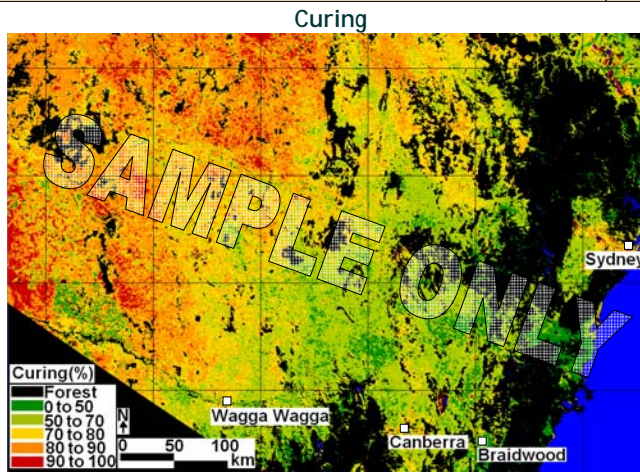
## Samples of a spatial curing product

Braidwood (NSW)



Using the Braidwood relationship between Levy rod Curing and NDVI, we produced an example of a Curing map covering a portion of NSW

\* Product not yet ready for use. Do not try this at home



→ Samples of a spatial curing product (cont)

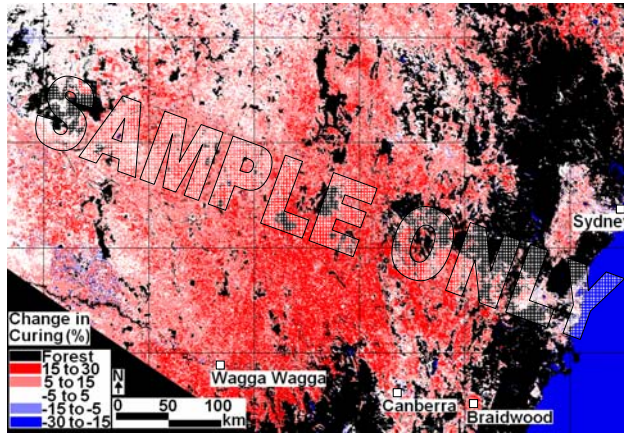
Change in Curing

Braidwood (NSW)

Using the Braidwood relationship again, this example shows the change in curing from the 30<sup>th</sup> September to the 16<sup>th</sup> of October

(Oct 16<sup>th</sup> minus Sep 30<sup>th</sup>)

\* Product not yet ready for use. Do not try this at home



Change in Curing Map: 30<sup>th</sup> September 2006 to 16<sup>th</sup> October 2006

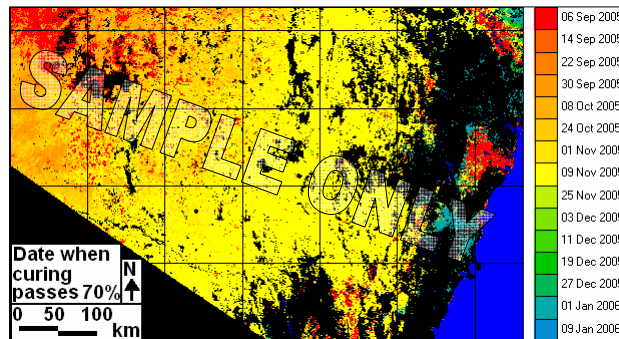
→ Samples of a spatial curing product (cont)

Date of Curing

Braidwood (NSW)

This map allows comparison of the progress of curing from one season to another

\* Product not yet ready for use. Do not try this at home



Date when grasslands become 70% cured, from September 2005 to January 2006



## CONCLUSION

The relationship between grassland curing and NDVI varied between sites due to climatic differences and variability in topography, soil type and grass type.

We will expand this study to understand these relationships across Australia and New Zealand, and assess the impact of grass and soil characteristics, with consideration of topography, climate and tree cover.

Information produced can be used for a range of fire management activities, such as prevention and preparedness planning, fire suppression operations, and for implementing controlled burning programs. It can also link in with other research and outputs from Bushfire CRC projects.



## ACKNOWLEDGEMENTS

Space Based Observations Section, [Bureau of Meteorology](#)

School of Mathematical and Geospatial Sciences, [RMIT University](#)

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## Combined FMC methods

Five separate live and dead grass samples were collected from each site, as well as five combined (live and dead) samples.

Samples were oven-dried and weighed.

Curing was calculated using the following formula:

$$\text{Curing (\%)} = \frac{(\text{Live FMC} - \text{Combined FMC})}{(\text{Live FMC} - \text{Dead FMC})} \times 100$$

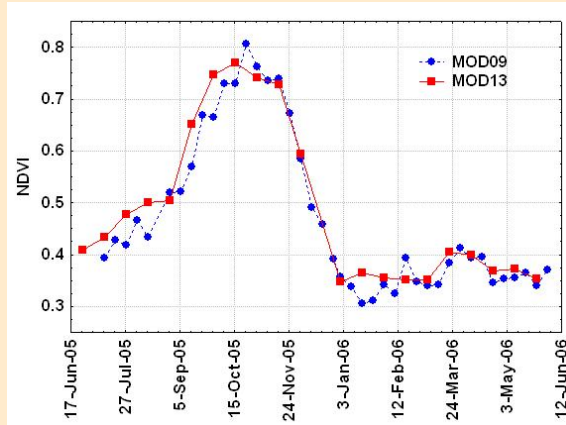


## Isodata unsupervised classification

- calculates class means evenly distributed in the data space then clusters the remaining pixels using minimum distance techniques.
- All pixels are classified to the nearest class unless a standard deviation or distance threshold is specified, in which case some pixels may be unclassified if they do not meet the selected criteria.
- 12 classes were requested to use this classification to mask out forests, and the sea for the curing maps.



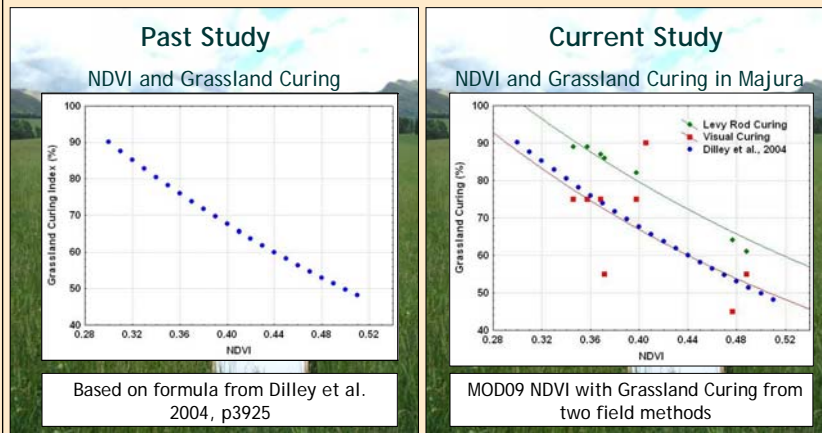
### NDVI - MOD09 and MOD13



MOD09 and MOD13 derived NDVI in Majura from July 2005 to June 2006.



### NDVI and Grassland Curing



A similar relationship was found in Northern Australia, however, the exponential curve found only in sites of **red** soils, with a linear relationship for **black** soils (Allan et al., 2003)