PROGRAM A

SPATIAL TECHNIQUES FOR GRASSLAND CURING ACROSS AUSTRALIA AND NEW ZEALAND

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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**

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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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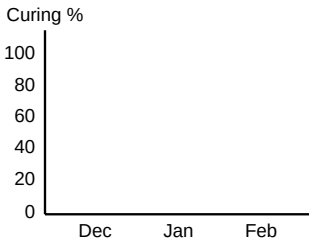
Grassland Curing

Green	Cured
Dec 16 2005	Feb 21 2006
60%	82%



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)
		(Rahman et al., 2003)	Chaparral/Grasslands (California, USA)
	SRI	(Tucker, 1979)	Grasslands (USA)
		(Sims and Gamon, 2003)	Mixed species (California, USA)
	EVI	(Cheng, 2006)	Rice fields (China)
Soil Correction	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)	Cotton fields (Arizona, USA)
		(Wiegand et al., 1991)	Crops (Texas)
	WDVI	(Qi et al., 1994)	Cotton fields (Arizona, USA)
Atmospheric Correction	ARVI	(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)
	PRI	(Rahman et al., 2003)	Chaparral/Grasslands (California, USA)
Bulk Canopy Pigments/ Nitrogen	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)

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

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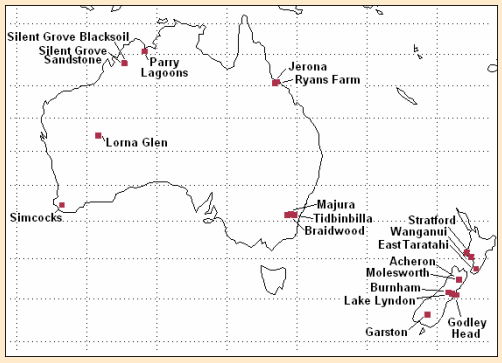
METHODS

Field

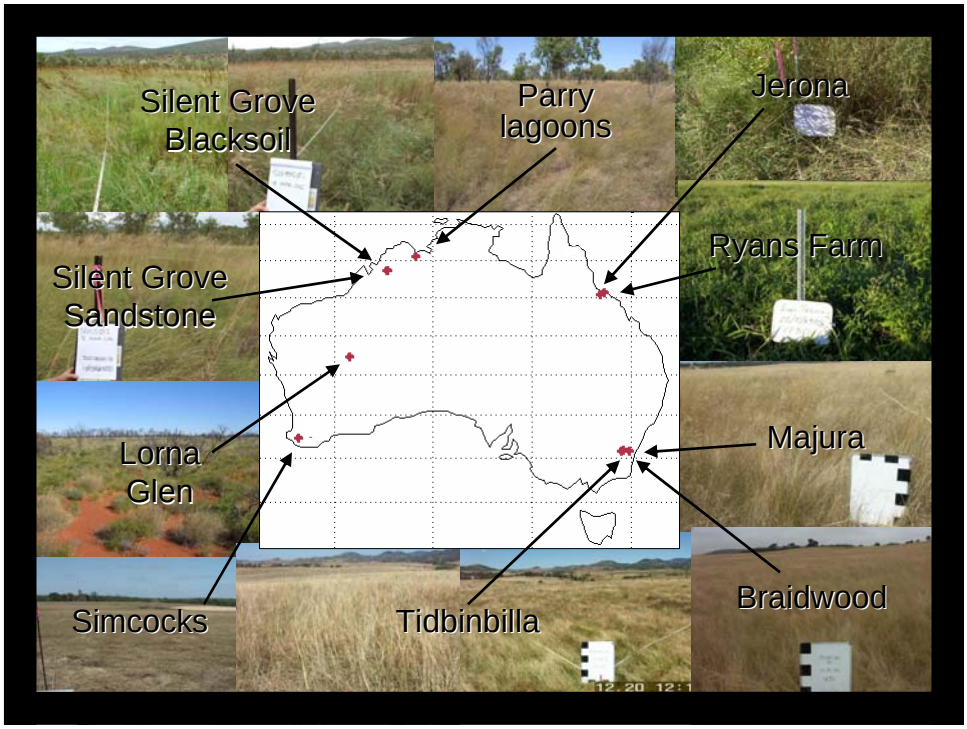
Fuel Moisture Content:
- Destructive sampling

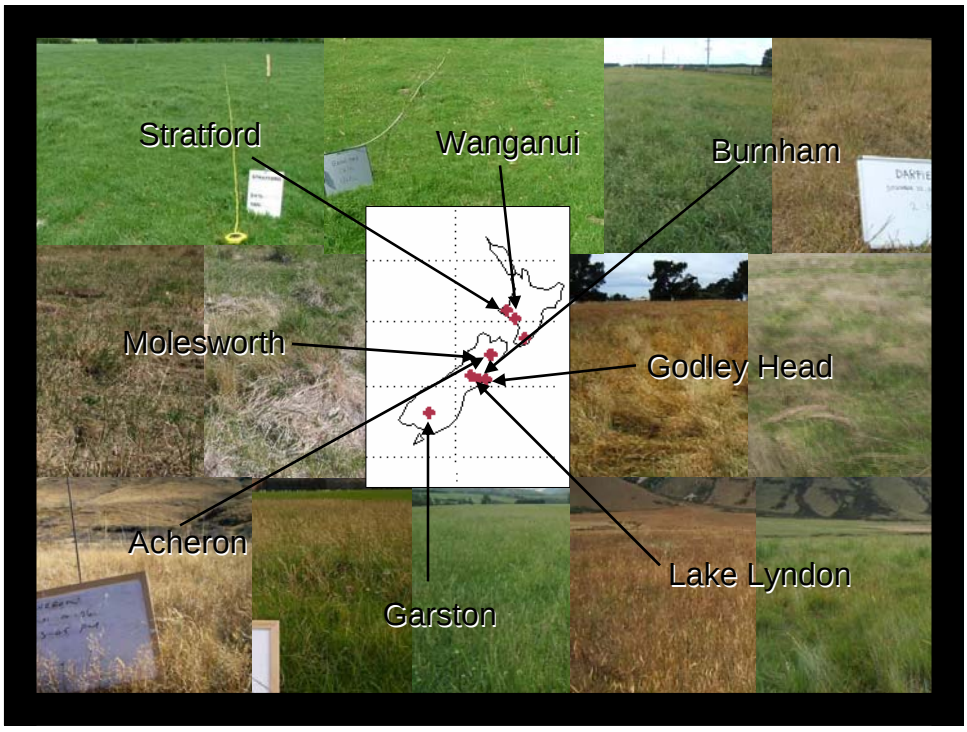
Grassland Curing:
- Destructive sampling
- Visual observations
- Levy rod sampling



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


Silent Grove
Blacksoil
Parry
lagoons
Jerona
Ryans Farm
Silent Grove
Sandstone
Lorna
Glen
Majura
Simcocks
Tidbinbilla
Braidwood


Stratford
Wanganui
Burnham
Molesworth
Godley Head
Acheron
Garston
Lake Lyndon

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

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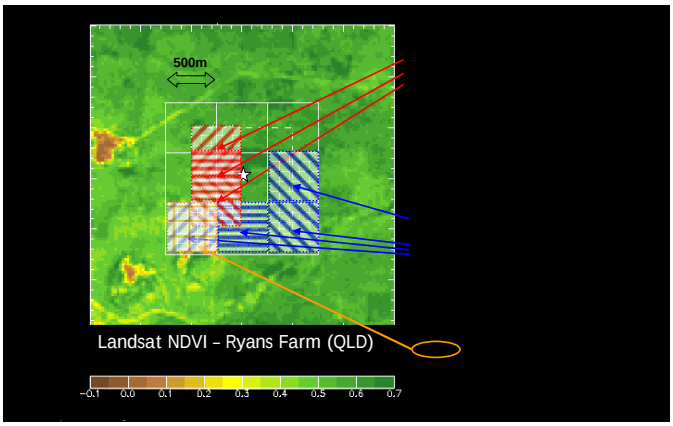
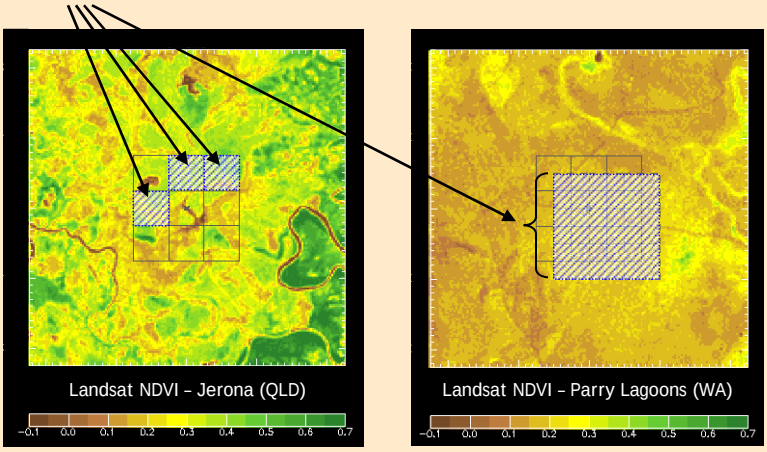
Site Selection and Characterisation

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



Site Selection and Characterisation (cont)

Selecting pixels



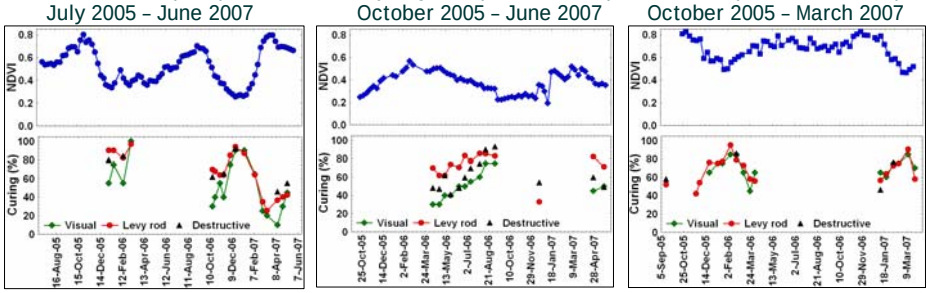
PRELIMINARY RESULTS

Curing and NDVI Time-series

Braidwood (NSW)
July 2005 – June 2007

Parry Lagoons (Northern WA)
October 2005 – June 2007

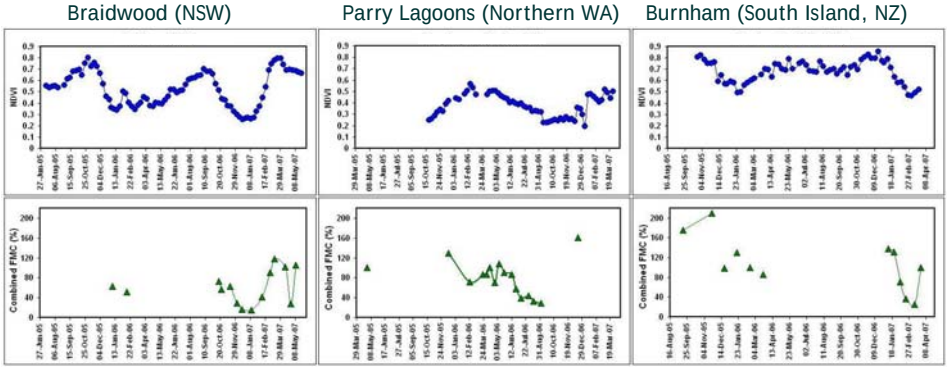
Burnham (South Island, NZ)
October 2005 – March 2007



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

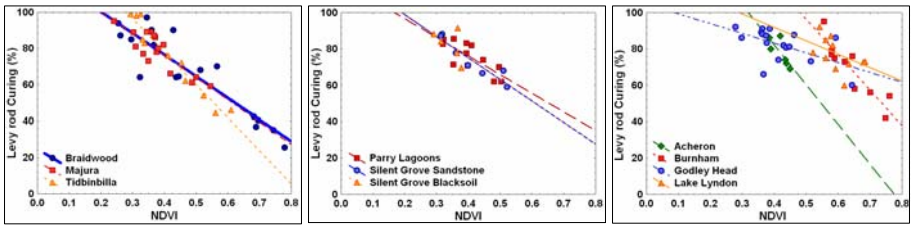
Braidwood (NSW) | Parry Lagoons (Northern WA) | Burnham (South Island, NZ)



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

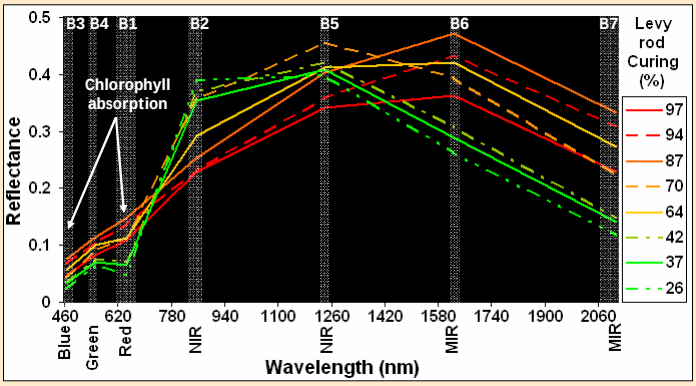
Correlation between Levy rod Curing and NDVI

NSW and ACT | Northern WA | South Island, NZ



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 MOD09's seven bands. Eg. The plot "70" represents the spectral signature from the 16th of October 2006, when (Levy rod) curing was 70%

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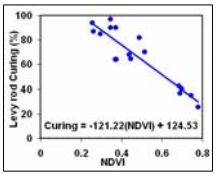
Samples of a spatial curing product

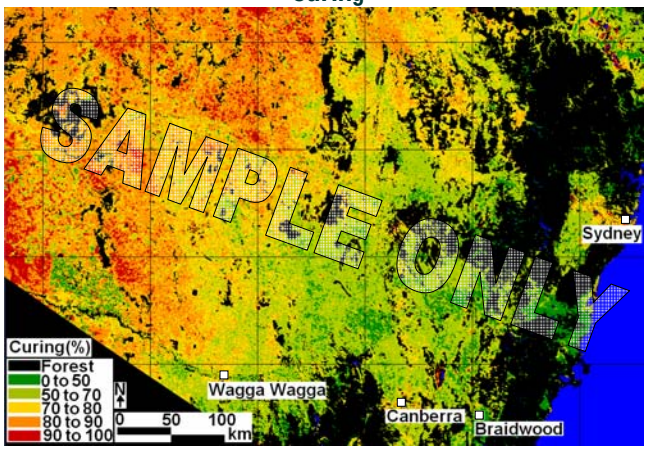
Braidwood (NSW)



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**

Curing



Snapshot Curing Map - 30th September 2006

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 30th September to the 16th of October

(Oct 16th minus Sep 30th)

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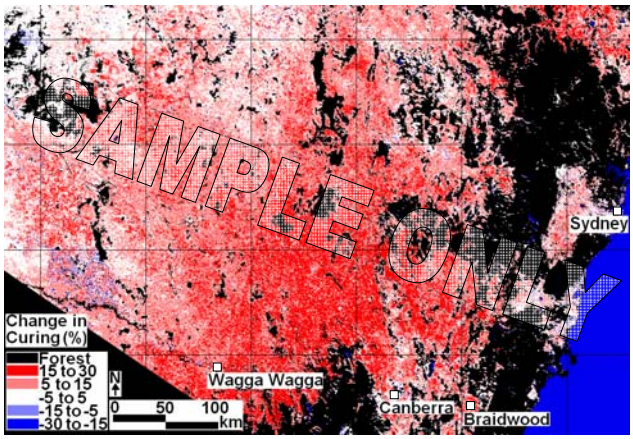

Change in Curing Map: 30th September 2006 to 16th October 2006

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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

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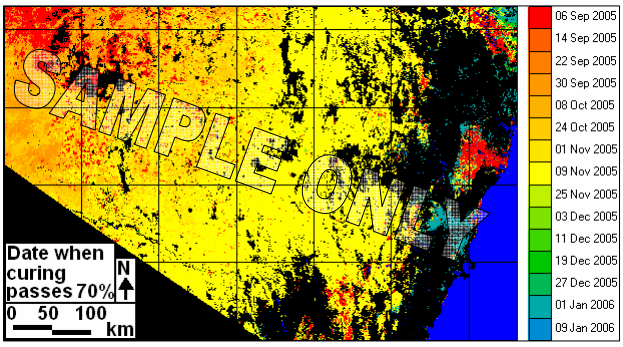

Date when grasslands become 70% cured, from September 2005 to January 2006

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.

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ACKNOWLEDGEMENTS

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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:

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

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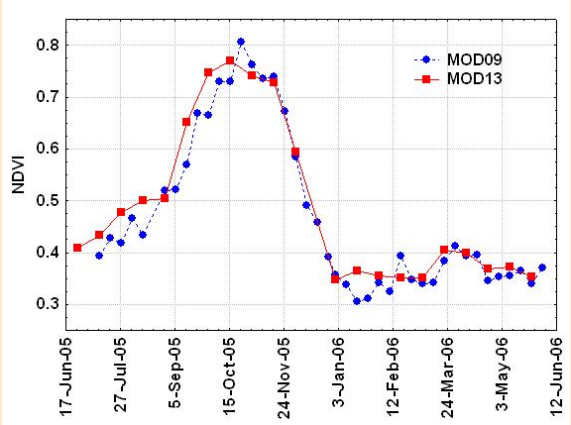
Isodata unsupervised classification

- 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.

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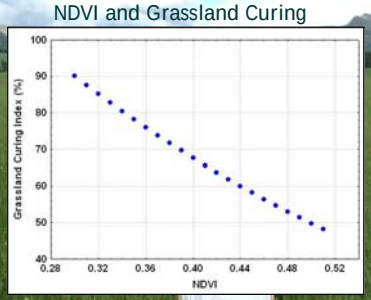
NDVI and Grassland Curing

Past Study

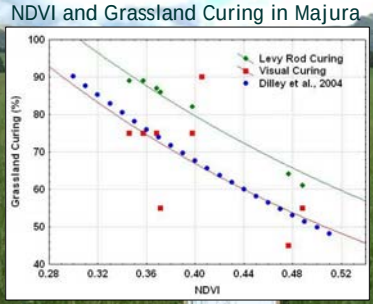
NDVI and Grassland Curing



Based on formula from Dilley et al. 2004, p3925

Current Study

NDVI and Grassland Curing in Majura



MOD09 NDVI with Grassland Curing from two field methods

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)