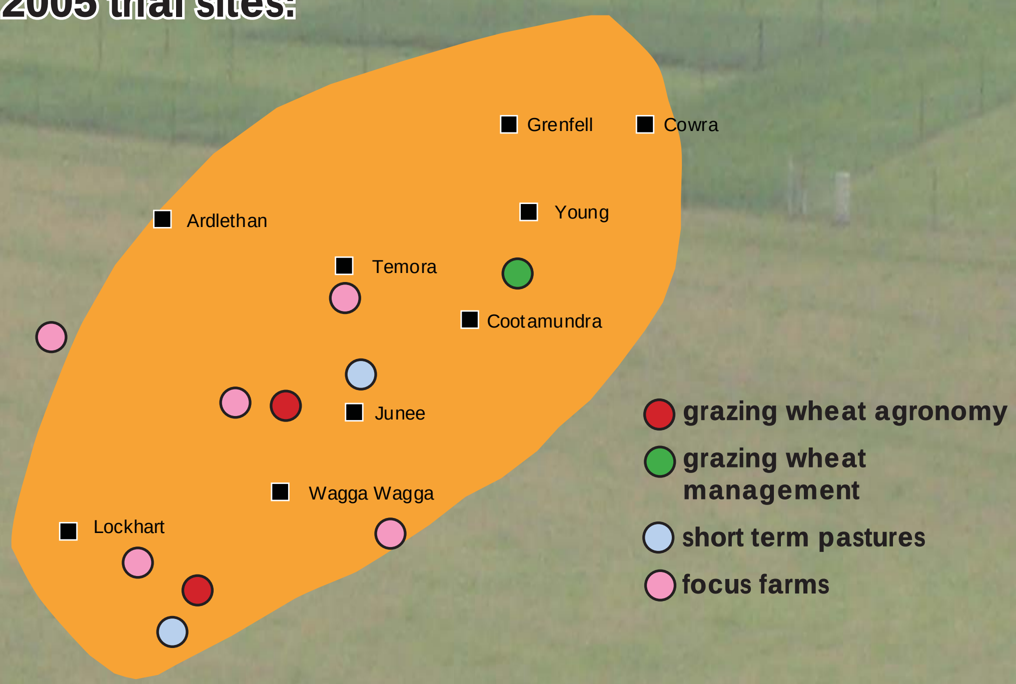
Research Priority:

addressing rotations for mixed farming systems

through Grain & Graze:

- **grazing wheat agronomy**
- **grazing wheat management**
- **short term pasture species**
- **focus farms**

2005 trial sites:



In collaboration with:

FarmLink Research
Murrumbidgee Catchment Management Authority
NSW Department of Primary Industries
CSIRO
Charles Sturt University

Funded by:

Grain & Graze
Profit through knowledge

Grain & Graze

filling the feed gap

The autumn/winter feed gap is a common problem in mixed farming systems. Although perennial pastures are an essential part of the farming system and have helped boost overall feed production, dry matter is generally limited after the autumn break when plants are recovering from a dry summer, through to winter when cold temperatures restrict growth. Supplementary feeding is often required to make up for this period of low production.

In recent years, the adoption of grazing wheats has increased rapidly as a profitable alternative to 'fill the feed gap', complementing perennial pastures which provide valuable feed throughout other parts of the year. Short term pastures (2-3 years) also provide another option for mixed farming systems to provide a short feed break in the middle of a cropping rotation, or sown in conjunction with perennial pastures to boost dry matter in the first few years.

The Murrumbidgee Grain & Graze project* is focusing on grazing wheats and short term pastures as profitable options for mixed farming systems. Results to date show the significant dry matter production of some grazing wheat varieties, and the impact this has on overall crop profitability. Initial results from the short term pasture trials show the potential for some annual legume species to provide high quality dry matter, lasting into the late spring, early summer period.

**The Murrumbidgee Grain & Graze project is a collaborative project between FarmLink, Murrumbidgee Catchment Management Authority, NSW Department of Primary Industries, CSIRO and Charles Sturt University.*

1. Grazing wheats - grazing and grain recovery

Project collaborators:
Guy McMullen[1], Jim Virgona[2], Kirrily Condon[3]
([1]NSW DPI, [2]CSU, [3]FarmLink)

2005 was the second year of the Grain & Graze project, continuing trial work on the agronomic aspects of grazing wheat varieties.

Aim: To determine dry matter potential, grazing/grain recovery and profitability of grazing wheats.

Table 1a - Site Details

Site Details	Marrar	Yerong Creek
Co-operator	David & Cathie Fox	Peter & Mark Yates
Sowing date (emergence)	S1: 5th May (dry) S2: 15th June	S1: 13th April S2: 14th June
Previous crop	canola	canola
Deep N	137kg N/ha	80kg N/ha
Plants/m^2	S1: 130/m^2 S2: 160/m^2	S1: 148/m^2 S2: 143/m^2
Grazing period	S1 & S2: 26th - 31st Aug	S1: 12th - 15th Aug S1 & S2: 27th - 29th Aug
Residual after grazing (kg DM/ha)	S1 & S2: ~600kg	S1: ~300kg S1 & S2: ~600kg
Stripe rust treatment	1L/ha Bayleton® @ GS65	500mL/ha Bayleton® @ GS37-39
Rainfall (Apr - Oct)	389mm	388mm

Figure 1a - Marrar trial (Aug '05)

Photo: K. Condon

Figure 1b - Yerong Creek trial (Aug '05)

Photo: K. Condon

Grain & Graze - replicated trials

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Method: Two sites were sown at Marrar and Yerong Creek (Table 1a) comparing a number of grazing wheat varieties at 2 sowing times. An ungrazed winter wheat and a spring wheat were also included in the 2nd sowing time for gross margin comparisons. Varieties included:

- Marombi
- Whistler
- Wedgetail (grazed & ungrazed @ 2nd sowing time)
- Diamondbird (@ 2nd sowing time)

Regular dry matter assessments (Table 1b) were undertaken by NSW DPI. Trials were harvested by AgriTech.

Results:

Grazing dry matter & growth rates:

As in 2004, dry matter production prior to grazing was highest in Whistler and Wedgetail (Figures 1c & 1d), with rapid early growth rates (Figures 1e & 1f). Marombi was again much slower to grow, consequently producing significantly less dry matter prior to grazing.

Dry sowing at Marrar also allowed Whistler and Wedgetail to produce significantly more dry matter than waiting to sow after the break (Figure 1c), despite only a few days difference in emergence times.

Early sowing at Yerong Creek following 10mm of rain (and 7mm 4 days later) allowed good establishment of the wheats. Although conditions then dried off until June, dry matter production from the early sowing was significantly better than waiting for the more general June rainfall (Figure 1d), and allowed 2 grazing periods.

Feed quality:

Feed quality of the grazing wheats was typically high with levels suitable for high animal production (Table 1b). The lower values at Yerong Creek reflect its more advanced maturity due to the earlier sowing.

Table 1b - Dry Matter (DM) & Feed Quality

Treatments	Grazing DM (kg/ha)	Digestibility %	Crude Protein %	Energy (MJ/kg)
Marrar	LSD = 154	11th August		
S1: Marombi	899	91%	34%	14
S1: Whistler	1367*	88%	33%	13
S1: Wedgetail	1288*	89%	36%	14
S2: Marombi	775			
S2: Whistler	1028**			
S2: Wedgetail	983**			
S2: Wedgetail UG	NA			
S2: Diamondbird	NA			
Yerong Creek	LSD = 432	16th August		
S1: Marombi	1804	80%	14%	12
S1: Whistler	2900*	72%	16%	11
S1: Wedgetail	2666*	76%	15%	12
S2: Marombi	537			
S2: Whistler	598			
S2: Wedgetail	639			
S2: Wedgetail UG	NA			
S2: Diamondbird	NA			

Note: *significantly better than Marombi (S1); **significantly better than Marombi (S2).

Grazing DM refers to the total dry matter available at the time of 1st grazing.

Figure 1c - Grazing Dry Matter at Marrar

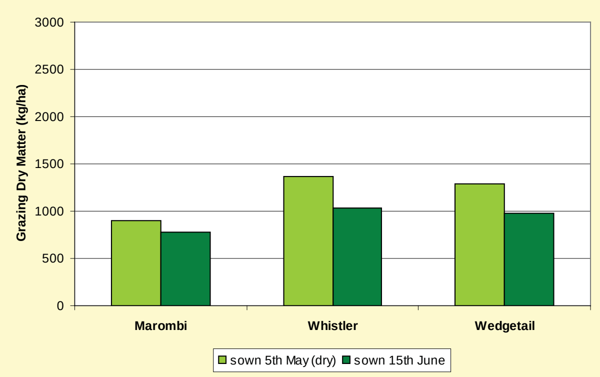
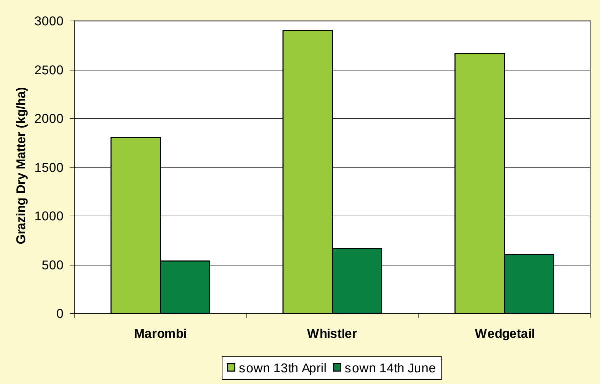


Figure 1d - Grazing Dry Matter at Yerong Creek



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Yield & grain quality:

Marombi produced significantly higher yields than the other grazing wheats again in 2005 at both sowing times (Figures 1g & 1h).

When compared with the spring wheat (Diamondbird), Marombi produced similar yields, whilst Whistler and Wedgetail generally yielded less.

Comparison of grazed versus ungrazed Wedgetail showed no yield differences at Marrar, but grazing resulted in a 9% yield decrease at Yerong Creek.

Dry sowing also proved beneficial to yields at Marrar, with each variety yielding significantly more (11 - 15%) with the earlier sowing. However at Yerong Creek, yields were lower at the earlier sowing time, reflecting over-grazing of these plots.

Protein was high at Marrar (up to 15%), with Wedgetail at both sites showing higher levels than other varieties. Screenings were also high at Marrar, particularly in the 2nd sowing time. Grazing did not affect screenings at either site.

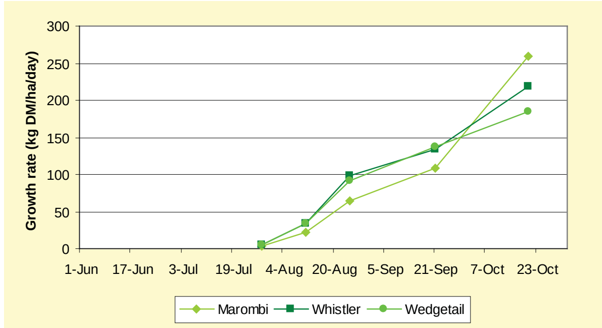
3. Economics:

As shown in 2004, the grazing value of grazing wheats made a significant contribution to their overall profitability (Figures 1i & 1j). Although Marombi produced the highest yields, returns from the grain generally weren't enough to make up for its limited dry matter production and consequent lower grazing value.

At Yerong Creek (1st sowing), both Whistler and Wedgetail gave greater returns than Marombi due to the large quantity of dry matter they produced. At Marrar, high protein values meant returns from Wedgetail were further boosted by the Prime Hard premium. Despite high dry matter production, returns from Whistler were lower due to its ASW classification.

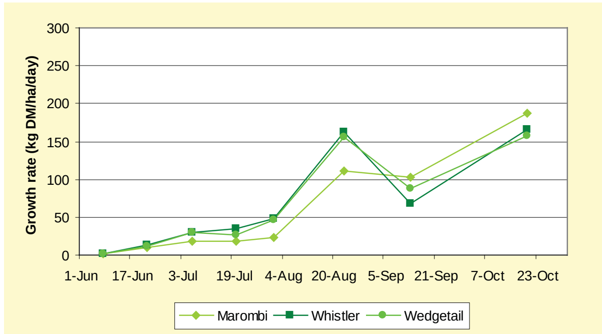
Acknowledgements: *Vince Van der Rijt (NSW DPI), Rod Fisher (NSW DPI), David & Cathie Fox (co-operators, Marrar), Peter & Mark Yates (co-operators, Yerong Creek), AgriTech.*

Figure 1e - Growth rates at Marrar (1st sowing)*



Note: *sown dry 5th May, emerged 18th June.

Figure 1f - Growth rates at Yerong Ck (1st sowing)*



Note: *sown 13th April into marginal moisture.

Table 1c - Yield & Gross Margins (GM)

Treatments	Yield (t/ha)	Grain GM ($/ha)	Grazing GM ($/ha)	Total GM ($/ha)
Marrar	LSD = 0.26			
S1: Marombi	4.1	$290	$169	$459
S1: Whistler	3.6*	$192	$256	$448
S1: Wedgetail	3.6*	$387	$242	$629
S2: Marombi	3.6	$221	$145	$366
S2: Whistler	3.3**	$135	$193	$328
S2: Wedgetail	3.1**	$277	$184	$461
S2: Wedgetail UG	3.1**	$274	NA	$274
S2: Diamondbird	3.5	$300	NA	$300
Yerong Creek	LSD = 0.22			
S1: Marombi	4.4	$378	$338	$716
S1: Whistler	3.7*	$259	$544	$803
S1: Wedgetail	3.6*	$310	$500	$810
S2: Marombi	4.7	$424	$101	$524
S2: Whistler	4.4**	$374	$125	$498
S2: Wedgetail	4.1**	$412	$112	$525
S2: Wedgetail UG	4.5	$473	NA	$473
S2: Diamondbird	4.5	$440	NA	$440

Note: *significantly lower than Marombi (S1); **significantly lower than Marombi (S2).

Grain GM calculated using AWB Pool Prices 29/9/05. Grain variable costs valued at $275/ha; additional fungicide cost for all except Marombi valued at $13/ha (incl. application). Grazing GM calculated using feed conversion ratio of 8, 47% dressing, valued @ $3.20/kg (no variable costs included).

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Figure 1g - Yields at Marrar

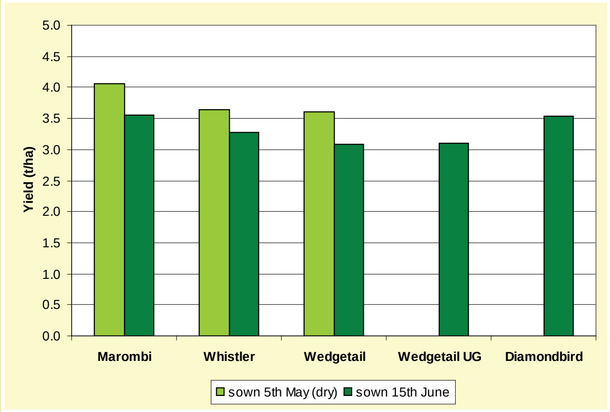


Figure 1i - Gross Margins at Marrar

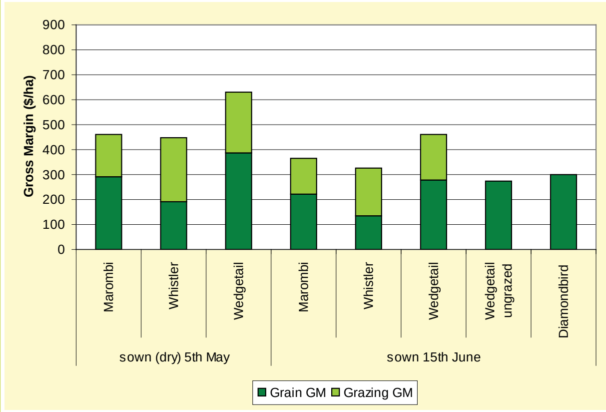


Figure 1h - Yields at Yerong Creek

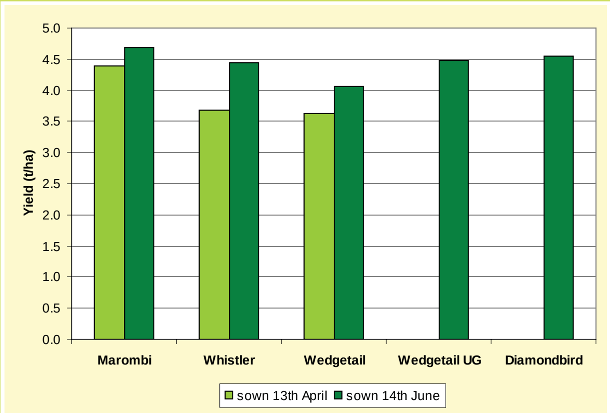
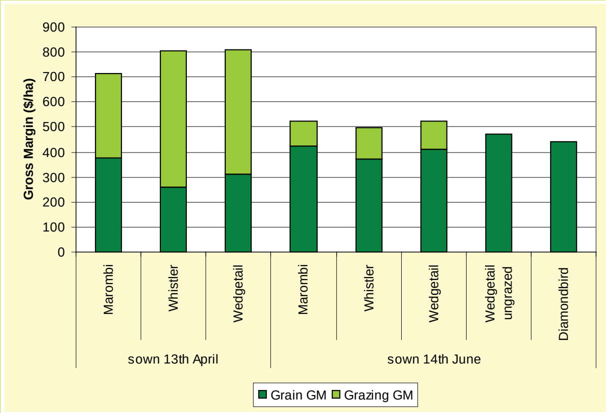


Figure 1j - Gross Margins at Yerong Creek



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2. Grazing wheats - water use

Project collaborators:
Warren Bond, CSIRO

As in 2004, daily soil water use was monitored in the Marrar grazing wheat agronomy trial by CSIRO (Warren Bond).

Aim: To compare water use between a grazed and ungrazed wheat, and a spring wheat.

Method: Soil water sensors* (Watermark® gypsum blocks) were placed at 20cm intervals to 1.6m below plots in the Marrar grazing wheat trial to measure water movement within the profile. Plots measured were:

- grazed wheat (Whistler)
- ungrazed wheat (Wedgetail)
- spring wheat (Diamondbird)

Data from the sensors was measured by loggers, which then 'radio-ed' results to a receiver at the nearby shearing shed. The receiver then sent the data by cdma telephone link to a computer at CSIRO, from where the data was automatically uploaded to a website for viewing by about 6am the next day.

**note that the sensors measure soil water potential rather than soil water content, but still give a useful, low cost method of comparing water movement within the profile.*

Results: Regular reports were written by Warren Bond to accompany the data posted daily on the website, which can be viewed via a link on the FarmLink website at:

www.farmlink.com.au/gg2.htm

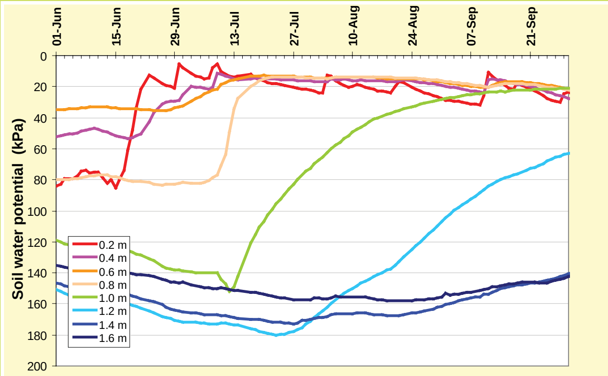
Following is a summary of results:

How wet did it get?:
Winter rainfall penetrated to 1.2m, 40cm deeper than in 2004. The soil was also wetter at each depth than in 2004, and stayed wetter for longer.

Figure 2a shows when the wetting front reached each depth in response to rainfall events, in particular:

- moisture from the breaking rains on the 10th June reached the 20cm depth by the 16th June, as seen by the sharp rise in Figure 2a, and 40cm depth by 19th June. (Note that as the soil becomes wetter, soil water potential

Figure 2a - Soil water potential for Whistler



Note: as the soil becomes wetter, soil water potential decreases.

Figure 2b - Soil moisture sensors in-crop

Photo: W. Bond

Figure 2c - Soil moisture sensors at harvest

Photo: W. Bond

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decreases). The subsequent rise and fall represents drying and wetting following further rainfall events.

- As rainfall continued, moisture penetrated deeper into the soil, reaching 60cm (27th June), 80cm (7th July), 1m (13th July) and 1.2m (25th July). It's unclear whether moisture reached 1.4m.
- All but the deepest 3 depths reached close to saturation (20kPa), remaining there until the end of September.

How dry did it get?:
Substantial drying to a depth of 1.2m (some evidence to 1.4m), indicates the depths at which roots were able to extract water from (Figure 2d). This was 20-40cm deeper than the drier 2004 season.

Does grazing affect water use?:
There was little difference in water use between the treatments until after grazing. From early September, the grazed wheat started to dry more slowly than Diamondbird at 20, 40 and 60cm (Figures 2e, 2f, 2g). Water use of the ungrazed winter wheat fell between the two. These differences, as found in 2004, still suggest that grazing causes decreased water use, although by the end of the season all treatments had dried to the same amount.

Fallow moisture:
Following early December rain, the soil profile re-wet to a depth of ~1m and has remained moist due to a combination of retained stubble and summer weed control.

This was also seen before sowing in 2005, despite the dry start. ~60mm in November and 64mm in January/February resulted in some moisture remaining in the soil down to a depth of 1m before the breaking rains in June.

Acknowledgements: *David & Cathie Fox (co-operators, Marrar).*

Figure 2d - Soil Drying

Soil Depth	Whistler grazed	Wedgetail ungrazed	Diamondbird
0.2m	drier than 200 kPa*		
0.4m			
0.6m	significant drying		
0.8m			
1.0m			
1.2m	some drying		
1.4m			
1.6m	no drying		

Note: *Watermark® sensors are only able to measure accurately to 200 kPa (wilting point is ~1500 kPa).

Figure 2e - Soil water potential at 20cm

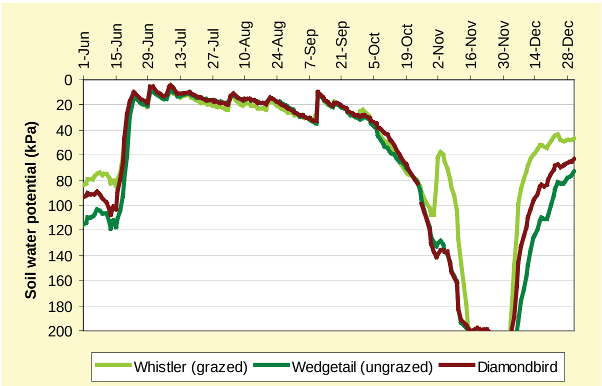


Figure 2f - Soil water potential at 40cm

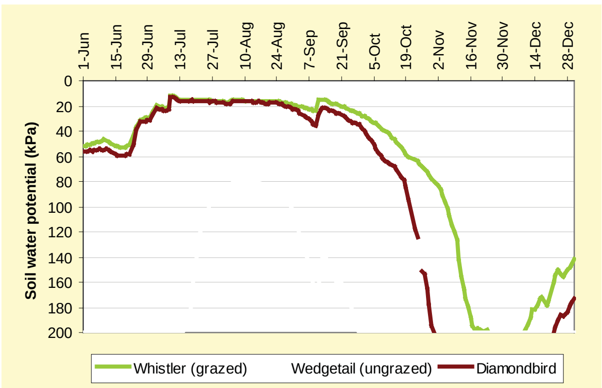
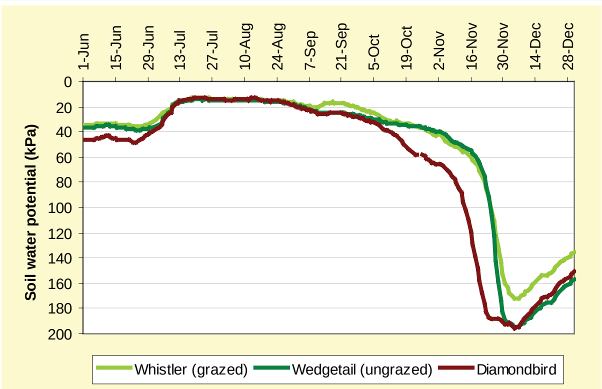


Figure 2g - Soil water potential at 60cm



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3. Grazing wheats - grazing management

Project collaborators:
Guy McMullen[1], Jim Virgona[2], Kirrily Condon[3], John Angus[4]
(*[1]NSW DPI, [2]CSU, [3]FarmLink, [4]CSIRO*)

Traditionally, advice regarding the grazing management of winter wheats has been conservative, with recommendations of high dry matter levels before and after grazing to ensure good grain recovery. However, research as part of the Grain & Graze project has shown that strong economic gains can be achieved by earlier commencement of grazing with higher stocking rates.

Aim: To determine the trade-off (if any) between grazing intensity and grain recovery in grazing wheats.

Method: The trial was established in a commercially sown paddock of Wedgetail, with 5 grazing treatments (Table 3b) imposing different levels of grazing intensity:

- ungrazed
- low stocking rate + early lock-up ('low/early')
- high stocking rate + early lock-up ('high/early')
- low stocking rate + late lock-up ('low/late')
- high stocking rate + late lock-up ('high/late')

50kg/ha nitrogen was also applied across the grazing treatments at 2 timings to determine the impact on yield and grain quality:

- (nil)
- lock-up
- pre-flower

Results:

Yield:

Grain yields were generally low due to the impact of diseases such as take-all and wheat streak mosaic virus. Despite this, there were significant differences between treatments, with highest yields achieved when stock were removed earlier, regardless of how heavy the crop was grazed. Yields declined by ~40% as a

Table 3a - Site Details

Site Details	Wallendbeen
Co-operator	Ken Jacobs
Soil type	Red Kandosol
Variety	Wedgetail
Sowing details	Sown 17th March @ 80kg/ha with 100kg MAP + Impact; 22cm row spacing.
Stripe rust treatment	1L/ha Bayleton® @ GS39
Stock type	Weaner lambs (~40kg)
Grazing commenced	11th July (~1800kg DM/ha)
Grazing lock-up	'early': 10th August - GS31 'late': 25th August - GS32*
Rainfall Jan to sowing	138mm
Rainfall in-crop	529mm

***Note: Growth stage at late lock-up was similar to early lock-up due to impact of grazing on delayed maturity.**

Table 3b - Grazing treatment details & results

	un-grazed	low/ early	high/ early	low/ late	high/ late
Stocking rate (DSE/ha)	0	17	31	18	33
Grazing days	0	28	28	43	43
DM at lock-up (kg/ha)	NA	2520	945	2034	725
Delay in flowering (days)	NA	7	9	9	16
Yield (t/ha) LSD = 0.35	3.2[b]	3.8[a]	3.9[a]	3.1[b]	2.3[c]
Protein % LSD = 0.54	14.2[a]	13.6[ab]	12.7[c]	13.3[b]	12.7[c]
Screenings % LSD = 2.1	2.7[b]	4.8[a]	4.3[ab]	6.3[a]	6.3[a]
Total gross margin* ($/ha)	$376	$694	$933	$639	$688

Note: Numbers followed by the same letter are not significantly different.

***Grain GM calculated using AWB Pool Prices 29/9/05. Grain variable costs valued at $275/ha; additional fungicide costs included (2 applications for ungrazed). Grazing GM calculated using feed conversion ratio of 8, 47% dressing, valued @ $3.20/kg (no variable costs included). Late grazing takes into acount of reduced liveweight gain during that period.**

Figure 3a - Trial site, Wallendbeen


Photo: G. McMullen

result of heavy grazing and late stock removal (Figure 3b).

Yields were strongly related to the number of grains, with no relationship to tiller number, grain size or dry matter.

Nitrogen applied post-grazing also had no impact on yield.

Grain quality:
Grazing impacted on grain quality, with protein decreasing and screenings increasing compared with ungrazed plots. Protein was lowest with the heavier stocking rates, while screenings were highest when stock were removed later.

Although nitrogen application timings had no impact on yield, they did affect grain quality. Protein levels increased when nitrogen was applied at lock-up, further increasing when applied pre-flowering (Figure 3c). Screenings were significantly higher with the 'lock-up' application but were not affected by the later application.

These results will need to be repeated to support the case for later nitrogen applictions to increase protein (particularly if growing AH or APH varieties), instead of nitrogen applied at lock-up, which has traditionally been the case, to increase grain yield.

Economics:
Gross margins show the benefits of grazing to crop profitability (Figure 3d). Even with conservatively managed grazing, gross margins increased by $245/ha, or 35% of the total gross margin. The more intense grazing strategies increased the value of the grazing component, offsetting the decrease in value of the grain component as a result of lower yields.

Flowering delay:
Grazing delayed flowering (Table 3b), by up to 16 days with high stocking rates and late stock removal. This is an important consideration for frost risk management or potential heat stress as flowering is moved later into the spring (Figure 3e).

Figure 3b - Yield response to grazing treatments

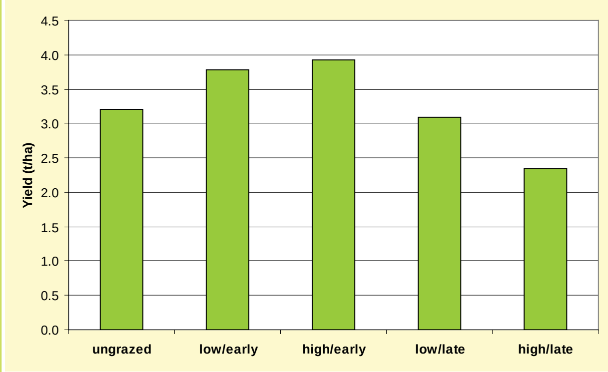

Figure 3c - Protein response to nitrogen timings

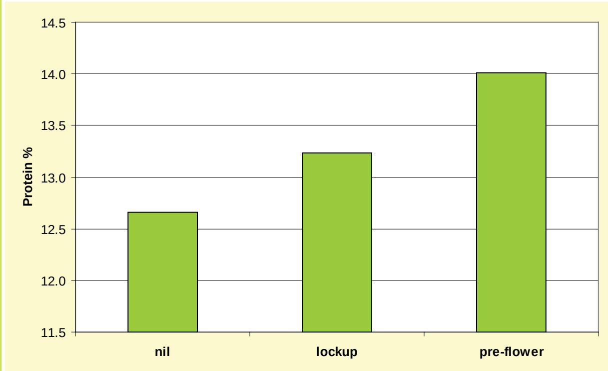

Figure 3d - Gross margins for grazing treatments

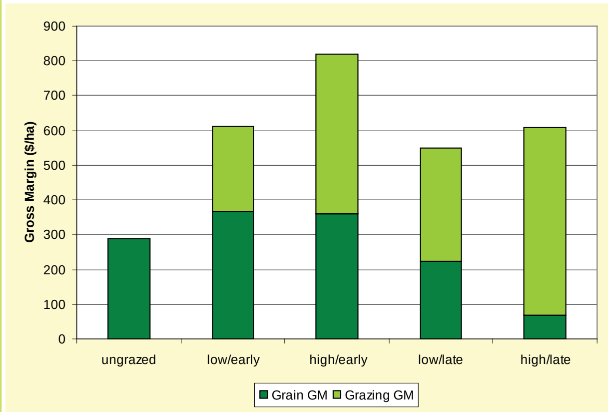

Figure 3e - Developing head in high SR, low SR, ungrazed (l to r)

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Water use:

As found in the grazing wheat agronomy trials in 2004 and 2005, water use by the crop is reduced after grazing (although total water use was the same as the ungrazed crop by the end of the season).

In the grazing management trial in 2005, there were again no differences in total soil water at flowering, but there were differences in the amount of water remaining at harvest. High stocking rates left significantly less soil water than the ungrazed treatment, suggesting greater water use between flowering and harvest. The higher yield from the earlier lock-up time may have resulted from a longer recovery period post grazing.

Soil structure:

The impact of grazing on soil structure was measured using shear vane measurements to indicate structural change. Results showed that soil strength increased with grazing, particularly under high grazing pressure (Figure 3f). Note that this is an indication only and is not directly related to any biological soil functions such as water infiltration.

Acknowledgements: *Vince Van der Rijt (NSW DPI), Rod Fisher (NSW DPI), Graeme Heath (NSW DPI), Ken Jacobs (co-operator, Wallendbeen).*

Figure 3f - Soil strength response to grazing

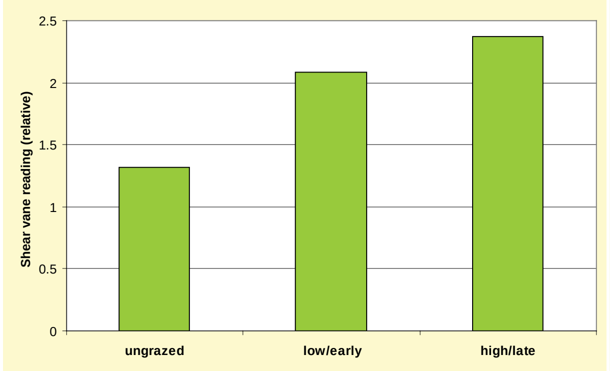

Figure 3g - Ungrazed, low SR, high SR (top to bottom), Aug '05

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4. Grazing wheats - liveweight gains

Project collaborators:
Hugh Dove[1], Guy McMullen[2], Jim Virgona[3], Kirrily Condon[4]
([1]CSIRO, [2]NSW DPI, [3]CSU, [4]FarmLink)

Very high liveweight gains can be achieved on grazing wheats, and can exceed those achieved on forage oats or pasture. However, trials have shown these weight gains to be highly variable, which do not appear to be related to cultivar preference, intake, digestibility or crude protein.

Research as part of the Grain & Graze project in 2005 showed significant liveweight responses to magnesium supplementation, suggesting magnesium may be contributing to the variability in liveweights recorded to date. These results need to be confirmed across seasons and soil types.

Aim: To determine the impact of magnesium and fibre supplements on liveweight gains achievable on grazing wheats.

Method: The trial was established in a commercially sown paddock of Wedgetail (Figure 4a), with 3 treatments fed ad lib to 37kg XB lambs (Figure 4b):

- nil supplement
- magnesium/calcium supplement (Causmag + lime + salt*)
- fibre supplement (oaten straw**)

**salt was used as an attractant to encourage consumption. Initially the mix was fed at a 1:1:1 ratio, but salt was then reduced by half.*
***oaten straw had 40% digestibility, 3.4% protein, 5.4MJ/kg energy and 80% neutral detergent fibre.*

Grazing commenced on 11th July with 35 DSE/ha, reducing to 25 DSE/ha a month later due to a lack of available feed. Stock were removed on the 25th August, leaving ~650kg DM/ha wheat, with no difference between treatments.

Results: An explanation of results has been prepared by Hugh Dove, with key points as follows:

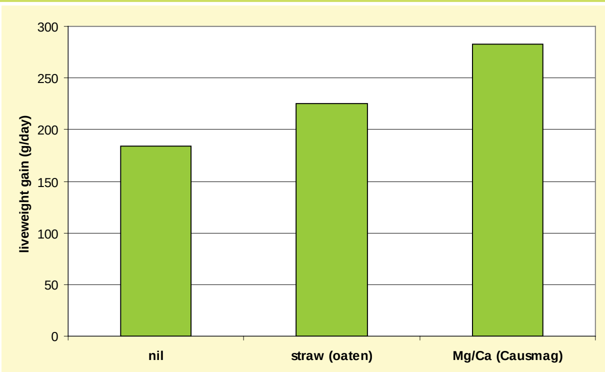
Figure 4a - Liveweight trial site, Wallendbeen

Photo: K. Condon

Figure 4b - Liveweight trial site, Wallendbeen

Photo: K. Condon

Figure 4c - Lamb liveweight response to supplements



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Lambs fed the magnesium supplement had significantly higher liveweight gains (54% higher) than those grazing on Wegetail wheat alone (Figure 4c). This extra liveweight was valued at ~15c/head/day, at a cost of 1c/head/day.

Lambs fed the straw supplement showed a 23% increase in liveweight over those with no supplement, though this was not statistically significant. The apparent difference may, however, be related to the extra magnesium provided in the straw rather than its fibre content, as grazing wheat itself contains adequate fibre levels. This is contrary to anecdotal reports that stock grazing cereal crops have benefited from extra fibre provided in supplementary hay, and needs to be confirmed by intake analyses.

Whilst the response to magnesium in this trial needs to be confirmed, there are a number of reasons to support the occurrence of magnesium deficiency. These include:

- low pH reduces magnesium absorption by the plant, so when wheat roots reach an acidic layer (common in surface soils across south-east NSW), transient magnesium deficiency can occur. If wheat is grazed during this period, the forage may be magnesium-deficient for stock. The issue may be resolved once wheat roots grow through to the (usually) less acidic subsoil.
- in the USA, cattle grazing winter wheats are routinely supplemented with magnesium as the forage is regarded as marginal to low in magnesium.
- magnesium intake problems in southern Australia are usually found in stock grazing all-grass or grass dominant pastures in winter which are high in protein and potassium, but low in magnesium (protein and potassium reduce magnesium absorption from the gut). This description also fits winter wheats.

Due to the association with potassium and calcium, measurements of magnesium alone in the plant or animal will not be adequate to determine whether magnesium is deficient. However preliminary investigations using a ratio of these 3 components have shown that all wheat tested was magnesium deficient. There is a need to clarify this across soil types and seasons.

The association with soil acidity and root growth also means the timing of the autumn break, sowing date and grazing time may impact on whether or not a response to magnesium is observed.

Acknowledgements: *Vince Van der Rijt (NSW DPI), Rod Fisher (NSW DPI), Graeme Heath (NSW DPI), Ken Jacobs (co-operator, Wallendbeen).*

Reference: *Dove, H. (2006). Grazing dual-purpose wheats for liveweight gain. 'Proceedings of the Technical Update, Industry Development (Broadacre Cropping) Unit, NSW Department of Primary Industries.'*

Figure 4d - Causmag, lime, salt supplement

Photo: K. Condon

Figure 4e - Oaten straw supplement

Photo: K. Condon

filling the feed gap

5. Short term pastures - species selection

Project collaborators:
Kirrily Condon[1], Guy McMullen[2], Greg Condon[3]
([1]FarmLink, [2]NSW DPI, [3]Grassroots Agronomy)

In addition to grazing wheats, short term (1 or 2 year) pastures are also being trialled in the Grain & Graze project as options to fill the feed gap in mixed farming systems. Sown as a component of the whole farm feed production system, short term pastures have the ability to produce high quality feed in the late spring/ early summer period when other pastures are starting to decline. Depending on the species, they can also provide a break-crop alternative for cropping rotations. Antas subclover performed particularly well in 2005, with rapid growth rates and high quality feed attributes.

Aim: To evaluate short-term (1-2 years) pasture species for their value in filling the feed gap and their 'fit' in the cropping rotation.

Method: Six short term pasture species were sown at 2 sites, Henty and Illabo (Table 5a), and compared with a grazing wheat (Wedgetail). The species, which were chosen for their potential late winter dry matter production, included:

- High density legumes (HDLs), consisting of Persian (Laser), berseem (Elite II) & arrowleaf (Zulu) clovers
- Balansa clover (Paradana)
- Subclover (Antas)
- Tetraploid ryegrass (Winterstar)
- Forage brassica (Winfred)
- Lucerne (Sardi 10 - highly winter active)

Dry matter cuts were taken by NSW DPI to monitor regrowth potential after grazing (simulated by mowing) and feed quality.

Results: Despite the late sowing, favourable spring conditions allowed reasonable dry matter production. Performance at the Henty site may have been limited by subsurface acidity.

1. Dry matter & growth rates:
As expected, dry matter production of Wedgetail far exceeded the pasture species

Table 5a - Site Details

Site Details	Illabo	Henty
Co-operator	Tony Lehmann	Graham Parker
Sowing date	29th June	28th June
Previous crop	wheat	canola
Deep N	74kg N/ha	121kg N/ha
Soil pH_{CaCl2}	5.0 (0-10cm)	4.9 (0-10cm) 4.5 (10-20cm)
Al %	1.5	2.6 (0-10cm) 9.8 (10-20cm)
Phosphorus (Colwell)	48	60
Rainfall (Apr - Oct)	436 mm	NA

Table 5b - Species performance

Species	Sow rate (kg/ha)	Plants /m²	DM* early Nov (kg/ha)	Dig. %	CP %	Energy (MJ/kg)
Illabo			4th Nov			
HDLs	12	162	2519	63	21	9.2
Paradana balansa	6	301	2897	66	20	9.8
Antas subclover	10	71	3878	71	21	10.6
Winterstar ryegrass	10	173	3208	72	10	10.7
Winfred brassica	4	110	2468	80	16	12.2
Sardi 10 lucerne	4	75	1438	64	17	9.5
Wedgetail	75	176	NA	61	8	8.8
Henty			11th Nov			
HDLs	12	104	2205	73	19	10.9
Paradana balansa	6	276	2878	68	16	10.2
Antas subclover	10	65	3436	66	19	9.8
Winterstar ryegrass	10	159	2977	75	9	11.2
Winfred brassica	4	87	1278	73	11	10.9
Sardi 10 lucerne	4	58	841	73	17	10.9
Wedgetail	75	146	NA	64	6	9.4

Note: 'DM' = dry matter, 'Dig' = digestibility, 'CP' = crude protein. *DM includes regrowth after 12th Oct cut.

filling the feed gap

in mid October (Figures 5a & 5b), although this is obviously well outside its grazing window. Results show that several pasture species have the potential to produce substantial quanitities of high quality dry matter to replace that being supplied by grazing wheats once they have been locked up.

In particular, Antas subclover, Paradana balansa, Winfred brassica* and Winterstar ryegrass produced quicker feed than the other species, up to 1500kg DM/ha by the middle of October (Figures 5a & 5b).

**Note Winfred brassica was affected by blackleg at Henty.*

By early November, Antas subclover had far exceeded the other species, growing at 120kg DM/ha/day at Illabo. (Subsurface acidity may have affected growth rates at Henty). Growth of the HDLs had also rapidly increased, as had Winterstar ryegrass and Paradana balansa with growth rates around 80kg DM/ha/day (Figure 5d).

Lucerne growth was slow, as was the Winfred brassica which showed symptoms of nitrogen deficiency at Illabo and blackleg at Henty. Commercial paddocks of Winfred brassica have shown it to have good dry matter and grazing potential (refer 'Forage brassica' monitoring results in On-farm Demonstrations, page 64).

2. Feed quality:

Digestibility (ie. % of feed which is actually retained in the animal) varied according to species. By the beginning of November, the digestibility of Antas subclover, Winterstar ryegrass and Winfred brassica at Illabo (also HDLs and lucerne at Henty) had remained above 70%, the level generally required for high stock production. In particular, Winfred brassica at Illabo reached 80%, signifying its high leaf to stem ration. In comparison, digestibility of Wedgetail had decreased below that of the other species as it entered its reproductive phase (Table 5b).

Energy levels are directly and positively related to digestibility, therefore followed the same pattern.

Figure 5a - Dry matter production at Illabo

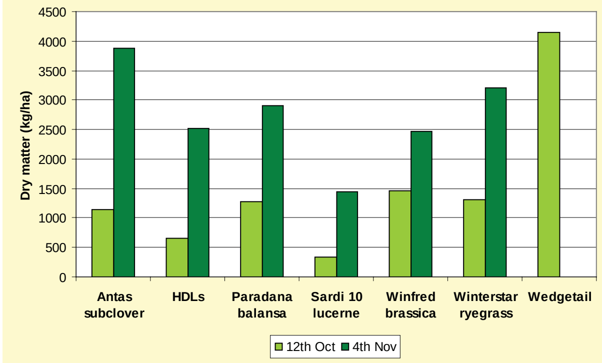
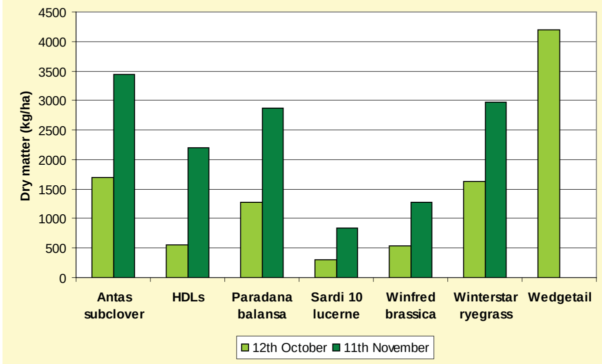


Figure 5b - Dry matter production at Henty



Note: dry matter of Winfred brassica limited by disease.

Figure 5c - Illabo trial (Winterstar, HDLs in foreground)

Photo: F. Gummer

filling the feed gap

Crude protein is also positively related to digestibility, although grasses are generally lower in protein than clovers. Consequently, both Winterstar ryegrass and Wedgetail had lower protein levels than the other species (Table 5b).

Acknowledgements: *Rod Fisher (NSW DPI), Tony Lehmann (co-operator, Illabo), Graham Parker (co-operator, Henty).*

Figure 5d - Growth rates at Illabo

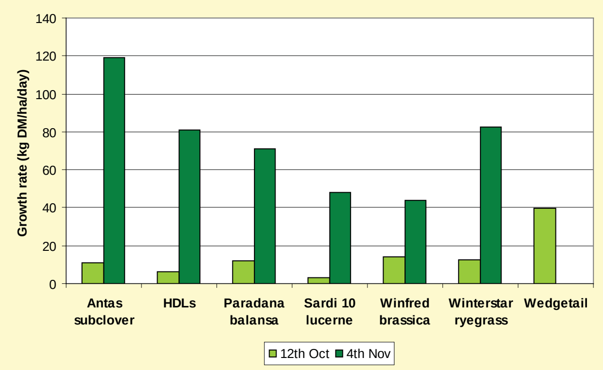


Figure 5e - Growth rates at Henty

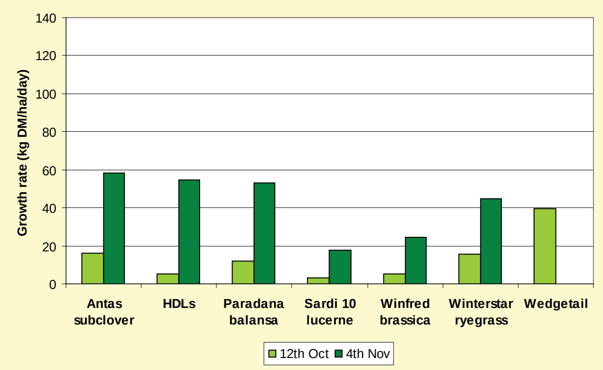


Figure 5f - Illabo trial (FarmLink Bus Trip 2005)

Grain & Graze

filling the feed gap

The Focus Farms are a joint initiative between the Murrumbidgee Grain & Graze and Best Management Practices for Dryland Cropping projects. Monthly monitoring of the Focus Farms is providing an overview of the feed production cycle on a whole farm basis and how this impacts on environmental indicators such as water use, ground cover and biodiversity.

The Focus Farm initiative has been funded by the National Action Plan for Salinity and Water Quality through the Murrumbidgee Catchment Management Authority (MCMA).

Focus Farms

Aim: To monitor whole farm feed production on mixed farming systems and the impact these have on natural resource management.

Method: Five Focus Farms were selected across the Murrumbidgee Catchment that were typical of mixed farms in their region. Locations include:

- Coolamon
- Euroley Bridge (Leeton)
- Sebastopol (Temora)
- Tarcutta
- Tootool (Lockhart)

On each farm, 5 paddocks representing typical components of a mixed farming enterprise were selected for monthly monitoring (Table 1a). The paddocks include:

- annual pasture
- perennial pasture (lucerne)
- native pasture/remnant vegetation
- grazing cereal
- grain only cereal

Monitoring activities on the Focus Farms can be divided into a number of components, including production, biodiversity and soil moisture as follows:

Table 1a - Paddock descriptions (dominant species)

Pdk type	Coolamon	Euroley Bridge	Sebastopol	Tarcutta	Tootool
annual pasture	sub-clover	sub-clover	sub-clover	sub-clover	sub-clover
perenn. pasture	lucerne /chicory	lucerne	lucerne	lucerne	lucerne
native pasture	k'roo grass, *stipa spp*	*danthonia, stipa* spp	*stipa* spp	red-grass	windmill grass, *stipa sp, juncus*
grain only cereal	wheat	wheat	wheat	barley	wheat
grazing cereal	wheat	oats	wheat	wheat	wheat

Figure 1a - lucerne paddock, Tarcutta (Feb '06)

Photo: D. Doyle

Figure 1b - native paddock, Tootool (Mar '06)

Photo: D. Doyle

filling the feed gap

1. Feed production and quality

Project collaborators:
Damien Doyle[1], Alison Bowman[1], ([1]NSW DPI)

To monitor feed production on a whole farm basis, Damien Doyle (Project Officer, NSW DPI) has been collecting the following data each month from the Focus Farms:

- dry matter
- pasture/crop growth rates
- feed quality
- ground cover
- soil moisture content
- soil characteristics to depth (once only)
- stocking rates & rainfall (provided by farmers)

Results: Monitoring results from the Focus Farms are produced by Damien monthly in 'Focus Farm Facts', which are available at www.farmlink.com.au/gg.htm

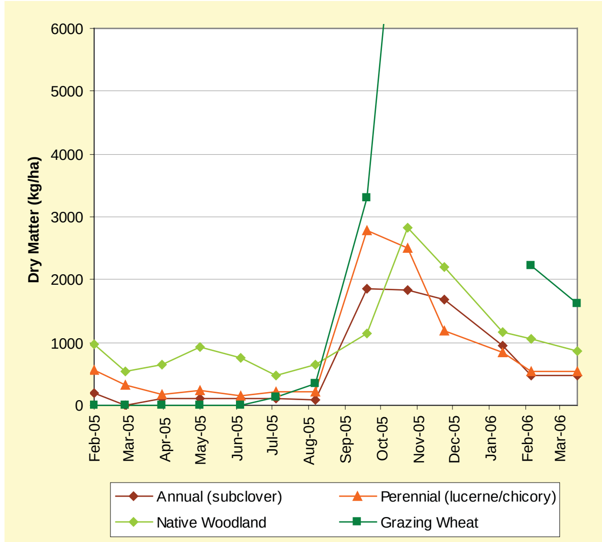
Dry matter production

With 12 months data now collected, whole farm feed curves have been created for each Focus Farm (Figures 1a - 1e) using the representative paddocks to identify surpluses and gaps in dry matter production. Whilst these are obviously driven by the 2005/2006 season, they do indicate typical periods of feed shortage experienced by mixed farming enterprises in this area. (Note that dry matter figures presented may reflect grazed dry matter.)

Across all farms, dry matter production was very low from February to August 2005. Although new growth was limited, residual dry matter in the native (or remnant vegetation) paddocks was highest during this period, which may reflect lighter grazing.

Following the breaking rains in the 2nd week of June, dry matter remained at a minimum due to a combination of slow growth rates (low leaf areas) and the need for grazing available feed. Feed supply didn't noticeably increase until September when growth rates exceeded stock demand in all paddocks to produce a

Figure 1c - Feed Curve, Coolamon



Note: lucerne cut for silage mid October.

Figure 1d - Feed Curve, Euroley Bridge

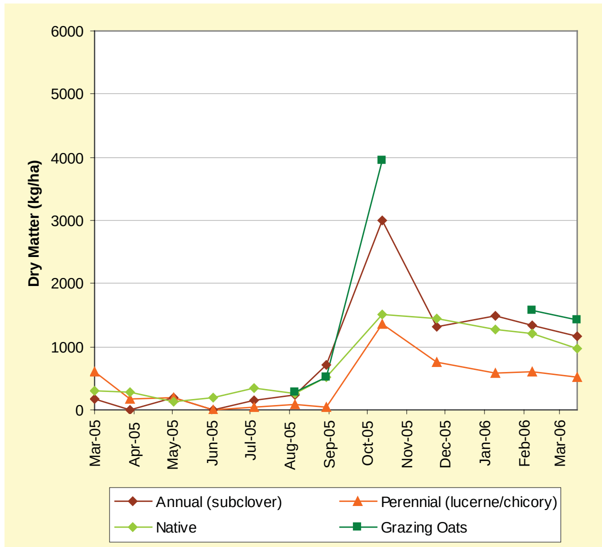
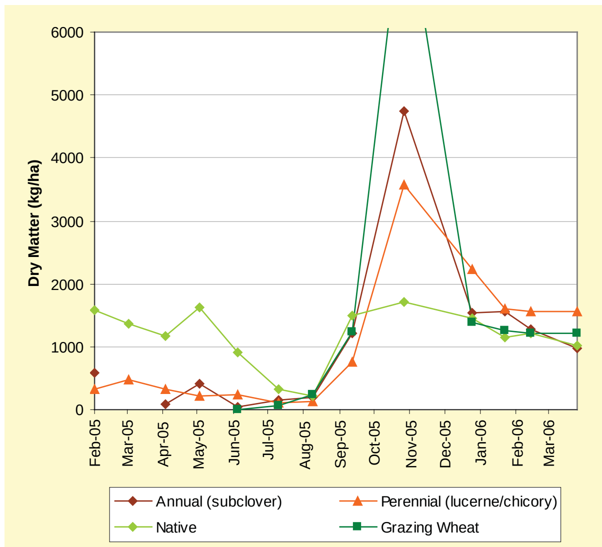


Figure 1e - Feed Curve, Sebastopol



filling the feed gap

late spring flush, peaking in November. Dry matter production was highest from the cereal crops, although this was obviously outside the grazing window.

Dry matter in the period from January to May 2006 was generally higher than the same period last year, with feed residue still being carried over from the abundant supply last spring. New growth has been minimal.

Pasture/crop growth

Pasture and crop growth rates increased rapidly from August, peaking in September/ October. Growth rate trends were similar between species and locations.

For example at Coolamon (Figure 1h), growth rates of the annual (subclover) and perennial (lucerne) paddocks peaked at 50-60kg DM/ ha/day respectively. Wheat growth rates increased to 150kg DM/ha/day in November.

Feed quality

Feed quality varied throughout the season. Using the Coolamon Focus Farm as an example, digestibility was above the desired 70% required for high production from August to October (Figure 1k over page), when actively growing green feed was available. As the plants senesced in late spring/early summer, digestibility dropped to levels that would be limiting production.

During its grazing period, grazing wheat peaked at 86% digestibility, declining to ~30% as a stubble. Lucerne generally had the highest digestibility throughout the year, maintaining a reasonable quanitity of green leaf. The digestibility of native pasture was generally lower throughout, peaking at 65% in spring.

As digestibility is directly related to metabolisable energy, the same trends have occurred. During summer, values ranged from just 3MJ in the wheat stubble to 7MJ in the lucerne, with 8MJ the suggested minimum requirement for dry sheep (Figure 1l over page).

Crude protein is also related to digestibility, but varies with species. Wheat again had very high protein levels (~33%) during the grazing period, but rapidly decreased during grain formation.

Figure 1f - Feed Curve, Tarcutta

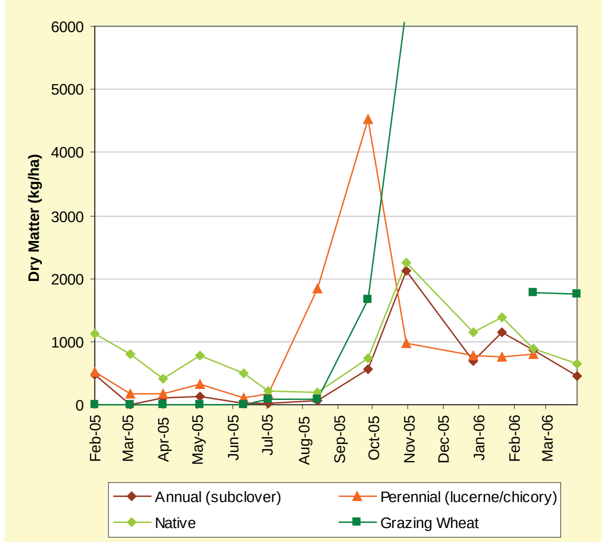


Figure 1g - Feed Curve, Tootool

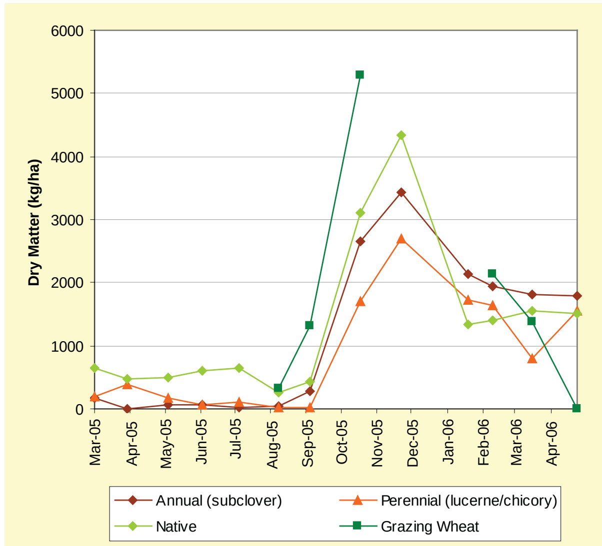
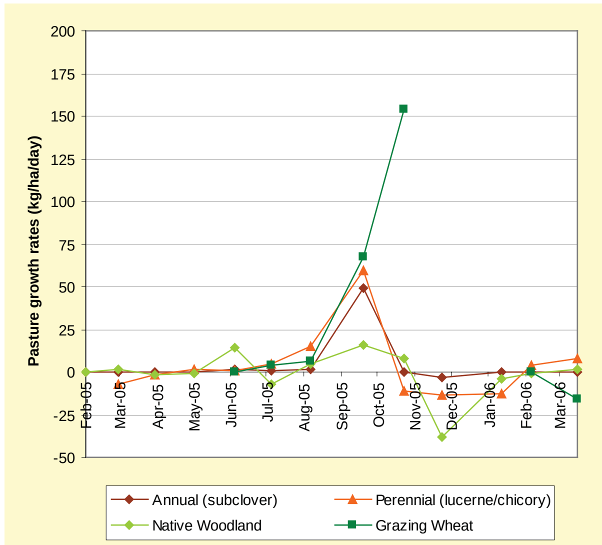


Figure 1h - Pasture/crop growth rates, Coolamon



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Both lucerne, and to a lesser degree subclover, had generally higher protein levels throughout the year, typical of legume based pastures (Figure 1m over page).

Ground cover

'Increasing duration of groundcover levels above 70% (50% for sandy loams), by at least 1 month a year for land used for agricultural production' is a major target in the Murrumbidgee catchment.

Again using the Coolamon Focus Farm as an example, ground cover in the native woodland and annual pasture was generally very high throughout the year, with just 2 periods below the 70% ground cover target in the annual paddock (Figure 1i) reflecting heavier grazing. Once established (spring sown 2004), cover in the lucerne paddock also increased to high levels, but tended to fluctuate with grazing pressure. The grazing wheat paddock had up to full cover in spring, declining to ~60% stubble cover.

Acknowledgements: *all Focus Farm co-operators, Robert Scriven (MCMA), Sheila de Lange (MCMA), Guy McMullen (NSW DPI), Nigel Phillips (NSW DPI), Greg Condon (Grassroots Agronomy), Kirrily Condon (FarmLink)*

Figure 1i - Ground cover, Coolamon

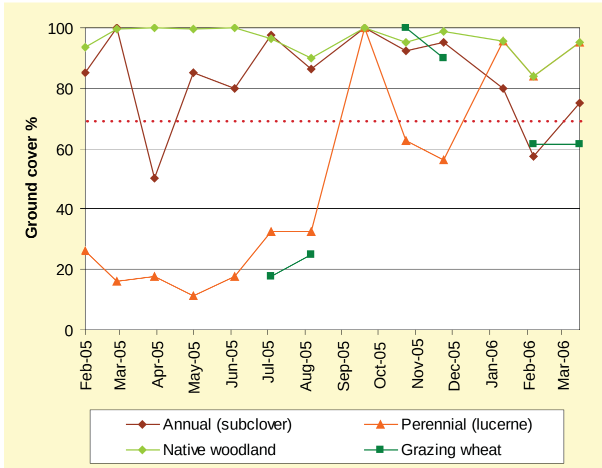

Figure 1j - Lucerne in Jan, Apr, May '06 (top to bottom)

Photos: D. Doyle

filling the feed gap

Figure 1k - Digestibility, Coolamon

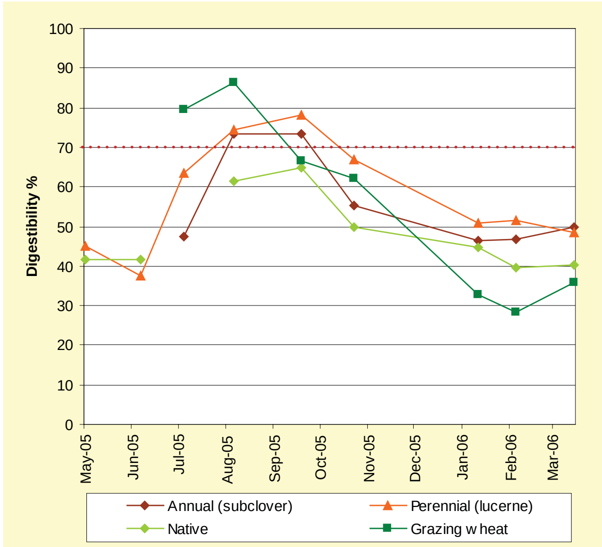

Figure 1n - lucerne/chicory, Coolamon (Jun '05)

Figure 1l - Metabolisable Energy, Coolamon

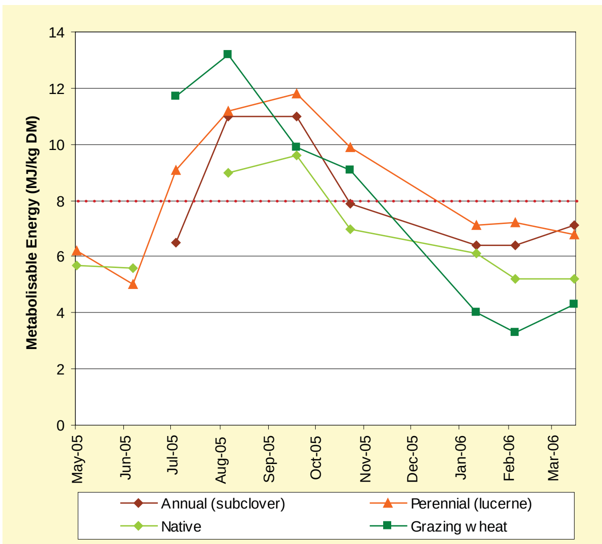

Figure 1o - cutting lucerne silage, Coolamon (Oct '05)

Figure 1m - Crude Protein, Coolamon

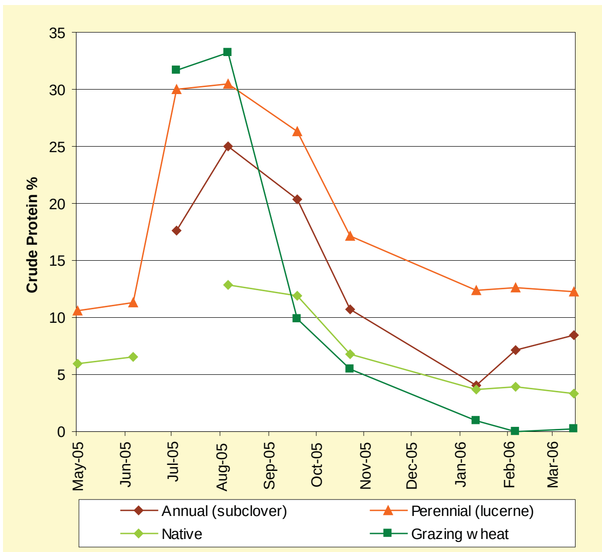

Figure 1p - annual pasture, Coolamon (Nov '05)

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2. Biodiversity

Project collaborators:
Sheila de Lange[1], Rob Scriven[1]
([1]MCMA)

Biodiversity is being monitored on each Focus Farm by Sheila de Lange (MCMA) as a component of the National Grain & Graze project. This component aims to determine the extent to which on-farm biodiversity is influenced by land use management, including cropping, grazing and non-productive or conservation areas, as well as by factors such as climate, soil type and topography. The data being collected includes:

- types of invertebrates (eg. spiders, ants & beetles) as indicators of environmental condition
- vegetation assessment (plant species and their abundance, ground cover, etc)
- soil microbial activity
- bird species
- soil characteristics (pH, phosphorus, nitrogen, etc)

Results: Biodiversity sampling commenced at the beginning of April 2006. Whilst all data collected is still being analysed in Tasmania through the National Grain & Graze project, some preliminary observations include:

- invertebrates - species found include ants (many types), wolf spiders, bees and beetles. There appeared to be fewer invertebrates in paddocks where stubble had been burnt.
- soil microbial activity - all farms showed some microbial activity, but tended to be less in drier locations. Initial observations also suggest there may be less activity in cropping paddocks than pasture or remnant vegetation paddocks, though this needs to be confirmed through analysis.
- bird species - preliminary results show that remnant areas of the farms had more bird species than other paddocks. Other remnant areas near the farm with similar vegetation also had more bird species than the on-farm remnant areas.

Figure 2a - MCMA Field Day, Tootool (March '06)

Figure 2b - Chocolate lillies in native woodland, Coolamon

Photo: D. Doyle

Figure 2c - Goanna in remnant vegetation, Sebastopol

Photo: D. Doyle

filling the feed gap

3. Water Use

Project collaborators:
Warren Bond, (CSIRO)

Warren Bond (CSIRO) has been monitoring soil water movement using electronic sensors in each paddock at the Coolamon Focus Farm to compare the effect of land use on soil moisture. Details of the paddocks are:

- annual pasture (Fig. 3a) - predominantly subclover for more than 5 years
- perennial pasture (Fig. 3b) - lucerne/chicory mix sown spring 2004
- native pasture (Fig. 3d) - ungrazed remnant woodland consisting of predominantly kangaroo grass and *Austrostipa* species (introduced annuals ~1% of the area)
- grazing cereal - wheat (Rosella)
- grain only cereal (Fig. 3e) - wheat (Rosella), ended up being lightly grazed

Soil water sensors* (Watermark® gypsum blocks) were placed at 20cm intervals to 1.6m at one point in each paddock to measure water movement within the profile. Data from the sensors was measured by loggers, which then 'radio-ed' results to a central base station receiver. The receiver then sent the data by cdma telephone link to a computer at CSIRO, from where the data was automatically uploaded to a website for viewing by about 3am the next day.

**note that the sensors measure soil water potential rather than soil water content, but still give a useful, low cost method of comparing water movement within the profile.*

Results: Regular reports were written by Warren Bond to accompany the data posted daily on the website, which can be viewed via a link on the FarmLink website at:

www.farmlink.com.au/gg3.htm

A summary of results was also prepared, with some of the key points as follows:

How wet did it get?:
Each paddock responded quickly to the breaking rains on the 10th June, with moisture rapidly reaching 0.4m depth. Moisture infiltration to lower depths continued at a

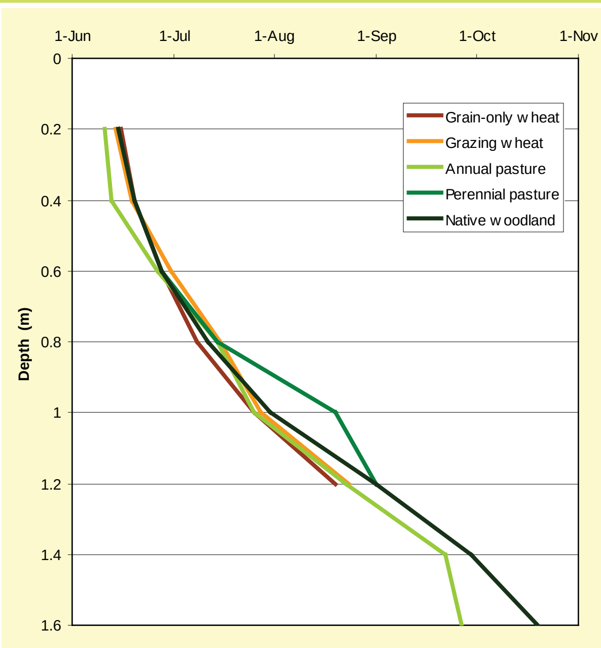
Figure 3a - Annual pasture (subclover) Aug '05

Photo: W. Bond

Figure 3b - Perennial pasture (lucerne) Aug '05

Photo: W. Bond

Figure 3c - Wetting Front Movement through Profile



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slower rate, which was similar in all paddocks up until the end of August (Figure 3c).

However from the beginning of September, rapid growth in the wheat and perennial pasture (lucerne) paddocks (Figure 1h, page 28) resulted in greater water use that only allowed spring rainfall to penetrate to 1.2m. In contrast, minimal growth and consequent water use in the native woodland allowed deeper water infiltration to 1.6m, which may also have been aided by improved soil structure expected in undisturbed soils. A relatively wet profile in the annual pasture paddock coming into winter meant it had less capacity to store winter rainfall, so moisture penetrated to 1.6m sooner than in the native woodland.

How dry did it get?:
Up until the 1st December, some drying had occurred down to at least 1.2m in all paddocks except the annual pasture, with the perennial pasture (lucerne) drying to 1.4m (Figure 3f). The soil was driest down to 60-80cm under the wheat and lucerne paddocks. Below that, some soil water remained unused by the wheat crops.

Over summer and autumn, the perennial pasture (lucerne) and native woodland have gone on to extract water from deeper in the soil profile, down to at least 1.6m. Some re-wetting of the soil has occurred under the wheat and annual pasture paddocks in response to summer rainfall, although wheat has now dried down to ~0.8m, probably as a result of surface evaporation and some weed growth. The soil under the annual pasture remains very wet, with shallow rooting causing some drying to only 0.6m.

Summary:
Overall, annual pasture has been the least effective at using soil water, resulting in lower dry matter production and a greater risk of groundwater recharge.

Wheat was the most efficient user of soil water in winter and spring due to high growth rates. Less vigorous growth from the perennial pasture (lucerne) and native woodland meant they used less water during this period, but their

Figure 3d - Native woodland (Sept '05)

Figure 3e - Wheat (Sept '05)

Figure 3f - Soil Drying up to 1st December

Soil Depth	Grain wheat	Grazed wheat	Annual pasture	Lucerne	Native wood
0.2m	drier than 200 kPa*				
0.4m					
0.6m					
0.8m	signif. dry				
1.0m					
1.2m	some drying				
1.4m					
1.6m	no drying				

Note: *Watermark® sensors are only able to measure accurately to 200 kPa (wilting point is ~1500 kPa).

filling the feed gap

summer activity resulted in greater water use over summer and autumn.

Figures 3g - 3i:
(Note: the higher the soil water potential, the drier the soil)

pre-season 2005 (before June rainfall):

- native woodland was dry throughout profile, as expected due to perennials and trees
- both wheat paddocks (canola stubble) had some moisture thoughout the profile, increasing with depth - due to a combination of water unused by previous canola crops, as well as moisture retained from summer rainfall (124mm Nov-Feb) through good fallow management
- annual pasture was dry to 40cm as rainfall from summer storms triggered growth. Shallow rooting depth meant water accumulated below 60cm.
- perennial pasture was dry to 1.2m, with further root growth gradually drying soil out to 1.6m

mid-season 2005:

- most paddocks were at their wettest, meaning rainfall exceeded evaporation and water use
- all paddocks were very wet down to 80cm; overall the annual pasture had the wettest profile, followed by wheat paddocks, then perennial pasture and native woodland

end of season 2005 (before Dec rainfall):

- wheat and perennial pasture paddocks were driest, drying down to at least 80cm
- annual pasture and native woodland were wetter, with the native area not starting to dry the soil down until mid December when growth rates increased. Shallow roots and poorer growth of annual pasture meant the soil never really dried much below 40-60cm at any time of the year.

Acknowledgements: *Ian Jennings (co-operator, Coolamon).*

Figure 3g - Pre-season Soil Water (1st June 2005)

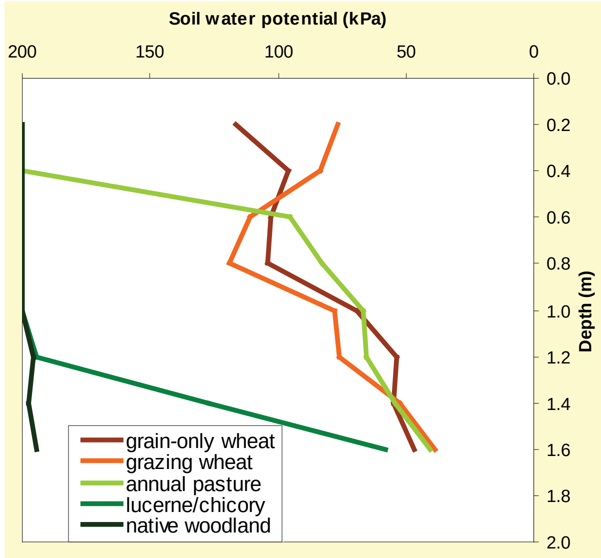

Figure 3h - Mid-season Soil Water (15th Sept 2005)

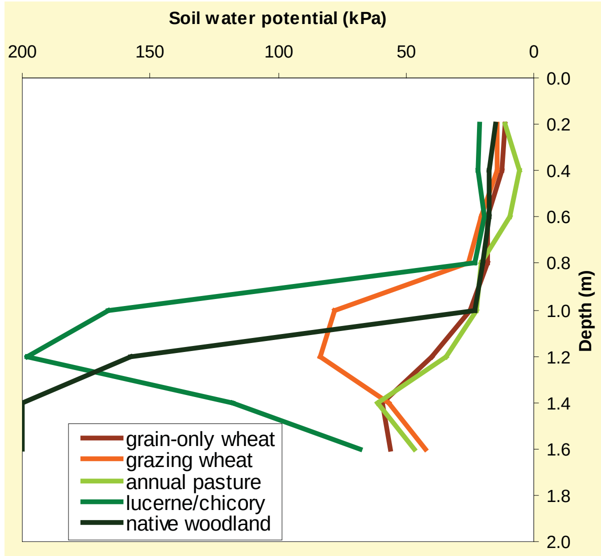

Figure 3i - End of Season Soil Water (1st Dec 2005)