BOOSTING WINTER PRODUCTION FROM LUCERNE BREAK CROPS

Bolac Plains Farm Walk

March 2, 2006

Grain & Graze™

Profit through knowledge

CORANGAMITE/GLENELG-HOPKINS

About these notes
These notes were prepared by David Watson of Agvise Services for the Grain and Graze program.

The field work was conducted on *Bolac Plains* Woorndoo by David Watson and property owner David Jamieson.

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The Grain and Graze program is based on co-operation between industry, government and regional natural resource managers.

Grain & Graze represents a first for Australian agriculture as four of the country's top Research and Development Corporations have joined forces to help farmer groups to deliver research and development activities. The national partners are Meat & Livestock Australia, Australian Wool Innovation Limited, Grains Research & Development Corporation and Land & Water Australia. The Corangamite and Glenelg Hopkins Catchment Management Authorities are also actively involved. The project is delivered by Southern farming Systems.

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Background

Poor winter and late summer pasture production are major constraints to overall animal productivity on farms in Western Victoria. Winter water logging can further restrict the ability of feed to grow over winter.

Lucerne has the potential to improve the summer production deficit if it can be successfully established, but limited winter growth, even using highly winter active varieties, can aggravate the winter feed shortage.

Lucerne is being investigated as a means of producing both quality feed in the summer and as a means of depleting soil profile moisture so significantly that winter water logging ceases to occur. Work by Southern Farming Systems has shown that lucerne can be grown successfully on clay soils in southern Victoria by establishment on narrow raised beds. However approaches to overcome the limitations to winter production from lucerne paddocks have not been widely examined.

Grain and Graze has recently completed a project examining ways of increasing winter production from established lucerne paddocks while minimising the impact on lucerne growth during the subsequent summer period. This involved the introduction of winter-active annual fodder species. The investigation was conducted on the property of David Jamieson, *Bolac Plains*, Woorndoo.

The systems approach to lucerne management

Lucerne has enormous potential in a mixed farming system. If winter active fodder species can be introduced successfully into lucerne grown on raised beds, a system could be developed where:

- Lucerne is grown in an environment that would normally prevent its establishment due to winter waterlogging.
- The extensive root system of lucerne would enable the plant to deplete soil profile moisture over summer to a point where winter rainfall in the subsequent year would not replenish the soil to saturation, thereby preventing the soil becoming waterlogged.
- High quality out of season summer feed is produced.
- Winter active fodder crops are established during lucerne dormancy, which produce large volumes of high quality feed during the winter.
- Total water use and water use efficiency is greatly increased above any other land-use system.
- Selection of the appropriate winter active fodder species allows ‘niche’ production to match animal requirements.
- Subsequent crop rotations will benefit by;
    - Introduction of significant amounts of nitrogen to the soil profile
    - Allowing the management of weeds, especially herbicide resistant ryegrass during the lucerne phase by winter cleaning
    - Providing decaying lucerne root pathways that encourage a proliferation of subsequent crop roots resulting in higher yields.

Key questions to answer about winter cereals sown into lucerne

The project was designed to investigate;

1. How much extra feed could be grown in winter by introducing winter active plants?
2. How much extra feed could be grown in total?
3. Would increasing winter production result in decreased lucerne production in winter and the subsequent summer?
4. What quality feed would be produced and what animal performance could be expected?
5. What would happen to the soil moisture status by growing extra feed in winter and summer?
6. Would the whole exercise be financially worthwhile?

Trial design and establishment

The paddock

The paddock selected was 'the Gums'. It had been sown to *Kaituna* lucerne (winter activity 5) in August of 2004 on 2.0m raised beds established in the same year. A sowing rate of 12.5 kg/ha had resulted in an extremely good establishment with plant densities in excess of 80 plants per square metre in the following winter.

Seasonal conditions

Bolac Plains has a 50 year rainfall average of 532mm per annum.

In 2005 the property experienced a very late autumn break (early June) and an unusually dry year. Rainfall was 351.5 mm for 2005 (66% of average) with 75mm falling in February. In the last 50 years there have only been two drier years.

Soils & fertility

The soil is a typical western district acid basaltic duplex clay loam over yellow clay with a variable buckshot layer separating the two. These soils are sodic in nature, with the exchangeable sodium around 10%. The soils typically become more sodic and less acid with depth.

'The Gums' paddock was treated with 2t/ha each of lime and gypsum at bed establishment (2004), resulting in an increased pH to 4.9 $CaCl_2$ (5.6 H_2O) and an aluminium of 0.5% of total cations. Exchangeable sodium declined to 2.9% after treatment.

Fertilizer history had been excellent with a soil phosphorus of 26.6 mg/kg (Olsen P) and a potassium of 246 mg/kg (Colwell K).

NB: Lucerne is sensitive to acid soils and responsive to good fertility. The measures carried out by David prior to establishment set the paddock up beautifully for success. This was reflected in the good establishment and early plant vigour and is considered an essential ingredient in success with lucerne.

Slope over the majority of the paddock is around 0.5%. This is considered ideal for raised beds with slopes much above 1% being sensitive to erosion and below 0.5% being subject to localised poor drainage problems. A small section of the paddock has low slopes and will prove interesting over time to observe the capacity of established lucerne to dewater soil profiles in this situation.

Layout

The 36ha paddock was subdivided with electric fences for the trial into six similarly sized blocks. Refer appendix 1 for schematic layout of trial.

Pre sowing preparation

The paddocks were heavily grazed through the autumn as per normal practice. This removed all lucerne foliage and most stalk and all 'trash', creating ideal conditions for direct drilling. No herbicide treatments were used prior to establishment.

Establishment
Four winter cereals and one fodder brassica were direct drilled into separate paddocks of one year old lucerne grown on beds. The cereals were selected to give a range of winter activities and periods of growth.

Species were direct drilled, using disc sowing modules under a John Shearer trash seeder, into the separate block of lucerne on May 25, immediately following 10mm of rain. One paddock was left as a control (lucerne only). Cereals were sown at 70 kg/ha and the fodder brassica at 3.0 kg/ha. Varieties used and there characteristics are shown below

Winter fodder crop selection

Block	**Variety**	**Characteristics**
#1, Oats	*Saia*	Black oat, general purpose grazing/forage.
#2, Triticale	*Crackerjack*	Medium-early maturity forage variety with good winter activity and early vigour.
#3,Wheat	*Mackella*	Red wheat with slow winter growth suited to some grazing with early sowing & good grain recovery
#4, Barley	*Dictator*	Extremely vigorous autumn winter production
#5, Control	No crop	
#6, Rape	*Winfred*	Commonly used as a carry over winter fodder crop in NZ

Fertiliser
All varieties were sown with 60kg/ha Mono Ammonium Phosphate. 100kg/ha of urea was topdressed on July 8 to all paddocks and a further 100kg/ha of "Pasture Booster" (7/3/30/6.7) was spread on September 30 to all paddocks.

Grazing management.
The trial was grazed with a number of different mobs of lambs. These including fine wool Merino lambs, Texel lambs and Merino x Border Leicester lambs. This allowed David to maximise the value of the fodder within the whole farm environment and has also allowed examination of the performance of different classes of sheep.

Actual performance to be compared to predicted performance using the CSIRO developed Grazfeed model.

Rotational grazing was adopted to ensure stand density and longevity. A six week rotation was employed, with mobs spending approximately one week in each paddock, until animal production targets had been achieved. The six week rotation was then continued with another mob. This is considered ideal for southern Victoria although a 4 paddock rotation over 4 to5 weeks is quite adequate to allow for stand recovery between grazing.

The movement of sheep around the trial was based on grazing heights (residual dry matter) that would ensure that neither the cereals nor the lucerne were grazed to a point where recovery would be compromised. The standards employed were for cereal height to be grazed no lower than 100mm (usually between 100 mm and 300 mm) and to avoid grazing the lucerne regrowth from the crown.

Feed budgets were used to determine mob size and grazing duration such that these grazing conditions were met. Mob size was calculated based on available feed and anticipated growth so that weekly movements would coincide with predetermined grazing heights.

Drymatter and livestock measurements
Dry matter determination from pasture cuts were carried out immediately before and after each movement of lambs in paddocks. These samples were partitioned into there components (lucerne or crop) and separately assessed by Feedtest for dry matter and quality.

Lucerne and cereal measurements were used as a basis for the feed budgets and to determine pasture growth. Pasture growth during the grazing period was calculated using these values and estimated consumption from Grazfeed predictions.

Lamb liveweights were taken regularly during and at the beginning and end of each grazing period.

Mobs entering the treatments were drenched with an effective drench and faecal egg counts were taken after 4 weeks. A drenching threshold of 150eggs/gram was set but never reached. The highest count was 120e/g therefore no drenching was carried out after sheep entered the trial

Removal of crop from lucerne in spring
From the outset it was intended that the cereal crops would be removed from the lucerne in the spring (early October) by heavy grazing. This technique involved grazing the cereal below the 100 mm minimum height after the first node had started to move up the stem. This was considered necessary so that the cereals would not be competing with the lucerne through the part of the year when the lucerne was most actively growing. It was anticipated that the remaining dry crop aftermath following heavy grazing and small amounts of residual regrowth would then be available as a fibre source for the sheep to balance the rapidly growing lucerne which would be very high in both protein and energy.

Soil moisture
Three permanent soil moisture probes were installed in each of the lucerne oversown with barley and control (lucerne only) plot, to measure the impact an active cereal crop would have on the soil moisture. Measurements were taken at 10cm intervals to a depth of 1.0m.

Results

The results are presented to answer the key questions posed in the introduction.

Question 1: How much extra feed could be grown in winter by introducing winter active plants?

The late break and the low rainfall over winter was expected to reduce production over the course of the trial. However the results still showed a significant difference despite the dry conditions, suggesting the differences may even be greater in an 'average' year. The total amount of feed produced is presented (table 1).

Table 1: Feed production during winter (1/6/05 to 31/8/05)

Treatment	Lucerne production (kg/ha)	Winter crop Production (kg/ha)	Total production (kg/ha)	Growth per day (kg/ha/day)	Variation from control
Oats + lucerne	1600	1200	**2800**	30.4	+27%
Barley + lucerne	1600	1500	**3100**	33.7	+41%
Triticale + lucerne	1450	1150	**2600**	28.3	+18%
Wheat + lucerne	1600	900	**2500**	27.2	+14%
Rape + lucerne	1500	400	**1900**	20.6	-14%
Control (lucerne)	2200		**2200**	23.9	0

Key points

- Total winter production increased in all cereal treatments.
- The *Dictator* barley produced the most dry matter over this time (3100 kg/ha) and grew 9.8 kg/ha/day more than the control (lucerne only). This equated to 41% increase in total production.
- *Mackella* winter wheat produced the least of the cereals with 2500 kg/ha grown or only 3.3kg/ha/day more than the control.
- The *Winfred* rape treatment produced 300kg/ha less feed over this period.

Question 2: How much extra feed could be grown in total?

The total difference in drymatter production to the end of the year is presented (table 2).

Table 2: Feed production during growing season (1/6/05 to 22/12/05).

Treatment	Winter production (kg/ha)	Spring, production (inc Dec) (kg/ha)	Total production (kg/ha)	Variation from control (kg/ha) & (%)
Oats + lucerne	2800	3909	**6709**	+2329 (53%)
Barley + lucerne	3100	3072	**6172**	+1791 (41%)
Triticale + lucerne	2600	3432	**6032**	+1651 (38%)
Wheat + lucerne	2500	3646	**6146**	+1765 (40%)
Rape + lucerne	1900	2417	**4317**	-64 (-1.5%)
Control (lucerne)	2200	2181	**4381**	0

Key points

- All cereals treatments grew significantly more feed over the course of the trial than the control (lucerne only)
- Oats performed best and grew 53% (2329 kg/ha) more feed than the control.
- Fodder rape had almost no different production from the control.

Figure 1: Total dry Matter Production of treatments during the year

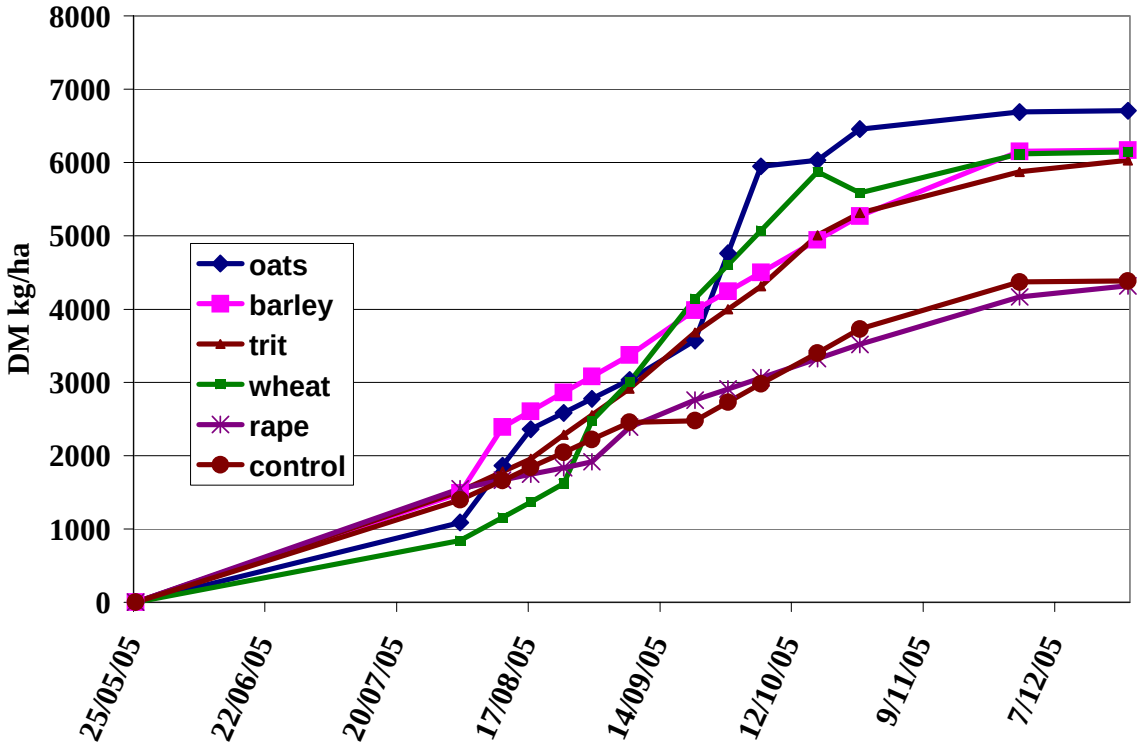


Figure 1 shows the cumulative total production for each treatment during the year. The height of the line shows the production and the slope of the line indicates the growth rate. The steeper the line, the higher the growth rate in that period. It can be seen that the barley and lucerne treatment has faster and greater growth during the winter compared with all other treatments. The oat treatment achieved the faster spring growth rate.

The decision of which cereal to sow is a matter of when the extra feed is required, either winter or spring (or both). Under most out of season finishing systems and in southern Victoria, winter feed shortage is the critical limitation to stocking rate and therefore measures that increase feed availability at this time are significant.

The red wheat was very slow to produce during the winter (figure 1), however the total production was equivalent to the barley and triticale. Triticale offered no advantage over any of the other cereals.

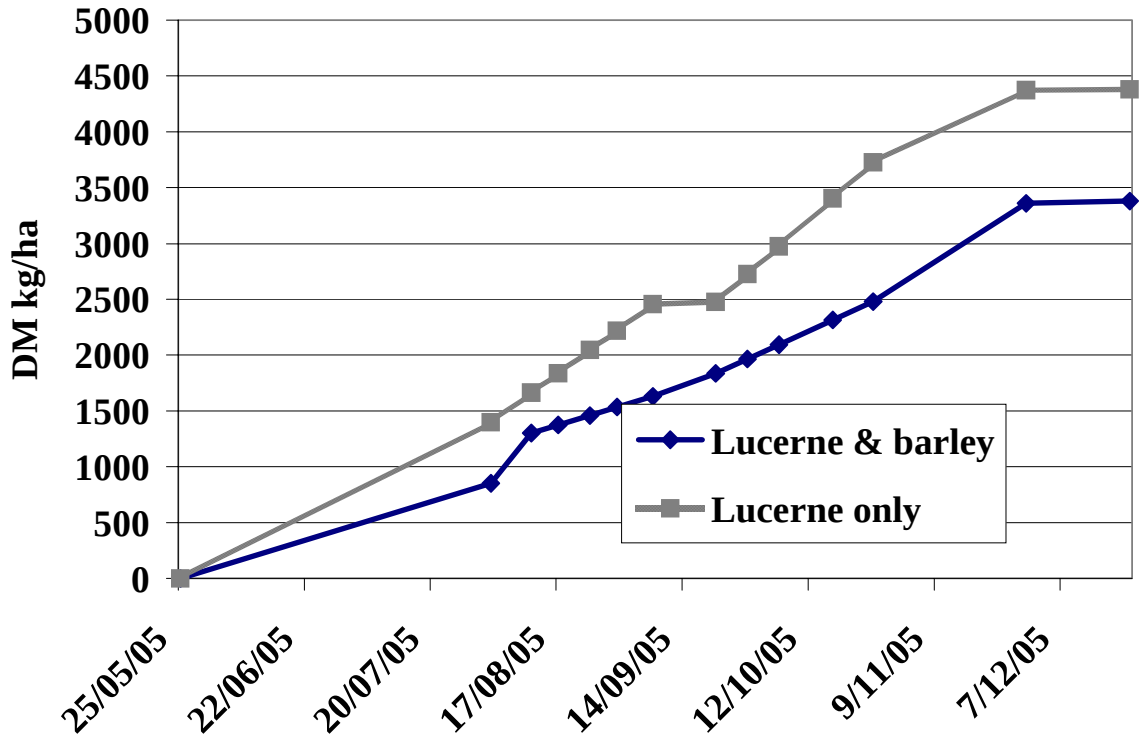
Question 3: Would increasing winter production result in decreased lucerne production in winter and the subsequent summer?

The introduction of winter cereals decreased total production of the lucerne. The combined results of the two most productive cereals, oats and barely compared to lucerne only are presented (Table 3 & figure 2). In both winter and spring lucerne production declined significantly in the cereal treatments.

Table 3: Lucerne Production throughout the year

	Winter (kg/ha)	Spring (kg/ha)	December (kg/ha)	Total (kg/ha)
Lucerne alone	2220	2154	7	**4381**
Cereals + lucerne	1532	1696	21	**3248**
Reduction in lucerne	-689	-458	+14	**- 1133**
Reduction in lucerne (%)	31%	21%	200%	**26%**

Figure 2: Impact on lucerne production of drilling in winter active cereal

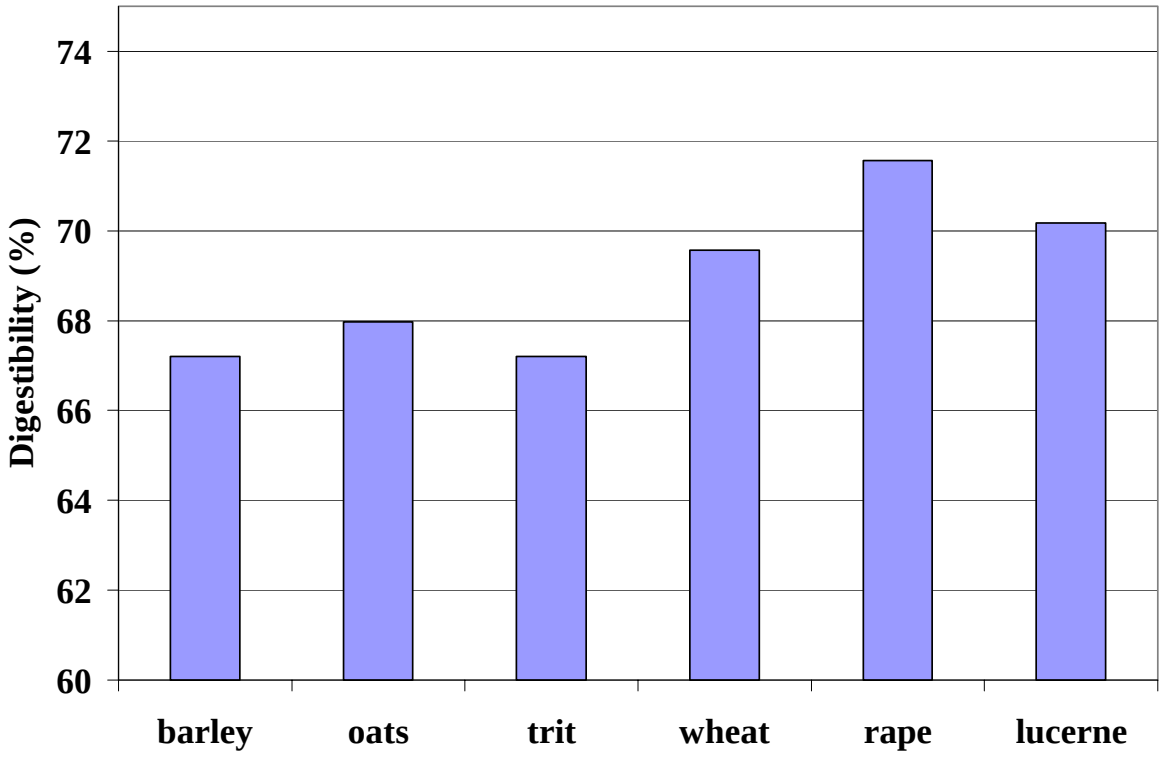


Question 4: What quality feed would be produced and what animal performance could be expected?

The average digestibility of the cereals during the experimental period is presented (figure 3). All the lucerne treatments sown with cereals show a small decline in digestibility over the lucerne only block (control). The rape treatment was slightly higher in digestibility although the rape only contributed 637 kg/ha or 15% of the dry matter of this treatment with lucerne contributing the balance. This reflects the high average digestibility of the rape of 83%.

The lower average digestibility of the barley and triticale was most likely a function of their early maturity. Conversely the winter wheat was slightly more digestible during the grazing period and may be explained by its later maturity and retention of vegetative leaf.

Figure 3: Average digestibility of all treatments and control



The collection of information on feed quantity and feed quality allowed predictions of animal performance, based on Grazfeed calculations to be compared to actual liveweight gain. Calculations were made based on the quality and quantity of feed for each paddock. Two mobs of lambs were analysed and the average of the results is presented (table 4). (FOO= Food on Offer).

Table 4: Lamb Performance, actual v predicted (Grazfeed)

	Merino Lambs	Texel lambs
Day grazing	48	25
Ave lwt, (kg)	33	29
Ave FOO (kg/ha)	1560	2000
Ave digestibility (%)	69	62
Ave crude protein (%)	28	28
Ave height of DM, (cm)	20	20
Weight gain, Kg	10.1	7.5
Grazfeed predicted daily gain, (gm/hd/day)	184	265
Actual daily gain, (gm/hd/day)	210	300
Actual gain compared to predicted (%)	+14%	+13%

In both of these mobs the actual weight gains exceeded the Grazfeed theoretical gains, by around 13%. Anecdotal evidence would suggest lambs grazing pure lucerne often fail to reach their theoretical potential, so this result is surprising and poses the question why have they performed better than expected? It could be speculated that the inclusion of leafy cereals in the diet complimented the lucerne, however it was beyond the scope of this trial to fully explore this hypothesis.

Fine wool merino lambs were used in the trial because of they were part of this mixed enterprise business and because of the desire of the manager to 'finish' them before the summer period.

However for most, the finishing of prime lambs would be of more interest. Modelling using Grazfeed illustrates the potential benefits of introducing cereals into existing lucerne. Using dedicated meat sheep as an example, using the same feed inputs but with a first cross, 35kg, wether, the predicted liveweight gain increases by 57% to 289g/hd/day.

Question 5: What would happen to the soil moisture status by growing extra feed in winter and summer?

To better understand the way in which a developing young lucerne stand extracts moisture from the soil and if the establishment of a winter active cereal would use significant amounts of moisture which would then be unavailable to the lucerne for production during the summer, 6 capacitance moisture probes were installed. They were located on one transect line (a bed) that runs through both the lucerne and barley treatment and the control (lucerne alone). Three probes were established in each treatment. See Appendix 1 (trial layout).

The capacitance moisture probes read moisture to a maximum depth of 1.0 metre at ten centimetre intervals. This information was collected at regular intervals from early September until January 2006. The results are presented in appendices 2 to 4. Comments inserted on this graphs help interpret the key messages.

In Appendices 3 & 4, the graphs for both the control (lucerne only) and the lucerne / barley treatment are presented. The graph is the total of all soil moisture readings through the profile (summed graph), in this case to a depth of 70cm. The graphs show there is little difference in the soil moisture extraction profile over time between the two treatments and although this is far from definitive, it does suggest that the addition of a winter active cereal did not increase the extraction of soil moisture.

Question 6: Would the whole exercise be financially worthwhile?

A simple partial budget was developed to examine the financial implications of using cereals in an established lucerne stand. Oats were used as a comparison to the lucerne only treatment (table 5).

Table 5: Net value of extra production of forage oats established in lucerne

PRODUCTION	**Assumptions**	**Per ha**	
Extra production		2300	kgDM/ha
Consume & waste		1.8	kgDM/hd/day
Grazing days		1278	
LWT gain	Ave 250 gm/hd/day	319	Kg LWT/ha

INCOME	**Assumptions**	**Per ha**
Value	$1.60/kg Lwt	$ 511

EXPENDITURE	**Assumptions**	**Per ha**
Seed	100kg at $200/t	$ 20
Sowing		$ 45
Fert, (50%)	100kg at $560	$ 56
Animal husbandry	$1/hd	$ 30
Mortality	1%@ $60/hd	$ 18
Selling costs	5% of gross	$ 26
	TOTAL	**$ 195**

		Per ha
MARGIN		$ 317

Results presented in table 5 show an extra margin of $316/ha may have been achieved from the oat/lucerne treatment.

This example uses the actual pasture production figures and assumes that a dedicated meat lamb finishing strategy would be employed. The live weight gain figures used are

conservative and were exceeded in this trial. This basic analysis assumes that all other costs such as subdivision and establishment of the lucerne stand is allocated to that exercise. This analysis only examines the extra costs and returns involved in establishment of a winter active cereal (oats) within the lucerne stand.

Discussion

This trial has shown that high quality, the oversowing of winter cereals can increase winter feed availability on lucerne. This extra production comes at little or no sacrifice to subsequent summer production of lucerne and therefore is a net gain to the system.

To quote David Jamieson

"Over sowing cereal provides excellent DM during the winter and responds very well to nitrogen. It looks as though Bolac Plains has increased the DM in the Gums by an extra 40% in a year with 351 mm of rain."

Livestock enterprise selection
The trial has also shown that this extra feed is extremely cost effective if a profitable animal enterprise is employed. For instance in the partial budget (table 5), if a fine wool merino wether lamb is substituted for the crossbred lamb the partial budget declines from $316/ha to $120/ha. This introduces the question "what is the best class of stock for this production system?"

To quote David again;

"It is very difficult to fatten merinos and the decision has been made to sell all the merino flock concentrate on the farming enterprise and graze the pasture and the lucerne rotation with prime stock"

During the winter most winter / spring lambing flocks are either in mid-late pregnancy or lambing. This is a critical time in the ewe reproductive cycle and ample, high quality feed at this time will increase lamb birth weight, resulting in better survival and growth, increase ewe milk production and hence lamb growth rates and increase ewe body weight thereby increasing conception rate at the next joining. The combination of these factors would result in a significant increase in the profitability of this enterprise and should be considered as an appropriate application of this production system.

Grazing management
During the course of the trial it became apparent that the strict rotational grazing protocols that were employed were necessary to maximise dry matter production. This was a short, intense grazing periods at high stocking rates (100 head/ha) which reduced wastage followed by about 35 days of rest which allowed maximum recovery. It id felt these grazing protocols also contributed to the animal performance exceeding the theoretical prediction of Grazfeed.

Prior to lambs entering the trial, David Jamieson pre conditioned the stock on a similar paddock of lucerne and winter cereals not part of the trial. This practice meant that the lambs 'hit the ground running' when they started grazing in the trial and suffered no set back at introduction. This is also a fundamental management message that should be employed in the commercial application of this system.

The very high animal production experienced in this trial indicates that the lambs experienced little or no dietary or animal health complications. On a pure lucerne diet red gut often occurs, and suppresses liveweight gain (possibly due to protein overload). The

introduction of the cereals may have contributed to a more balanced diet and largely eliminated this problem.

Lucerne survival
For favourable establishment cereals need to be drilled to a depth of about 3cm. This results in disturbance to the stand and possible injury to the lucerne crown, which may promote disease and reduce stand density and life. No evidence of this was observed during this trial. Lucerne plant populations were very high in this trial and the loss of some plants would have little impact on productivity. It is David's intention to set his seeder up to inter row sow in the future and this technique will eliminate the potential for this problem to arise. A bedded paddock easily allows this technique to be employed since accurate tractor guidance results from the wheels following the furrows

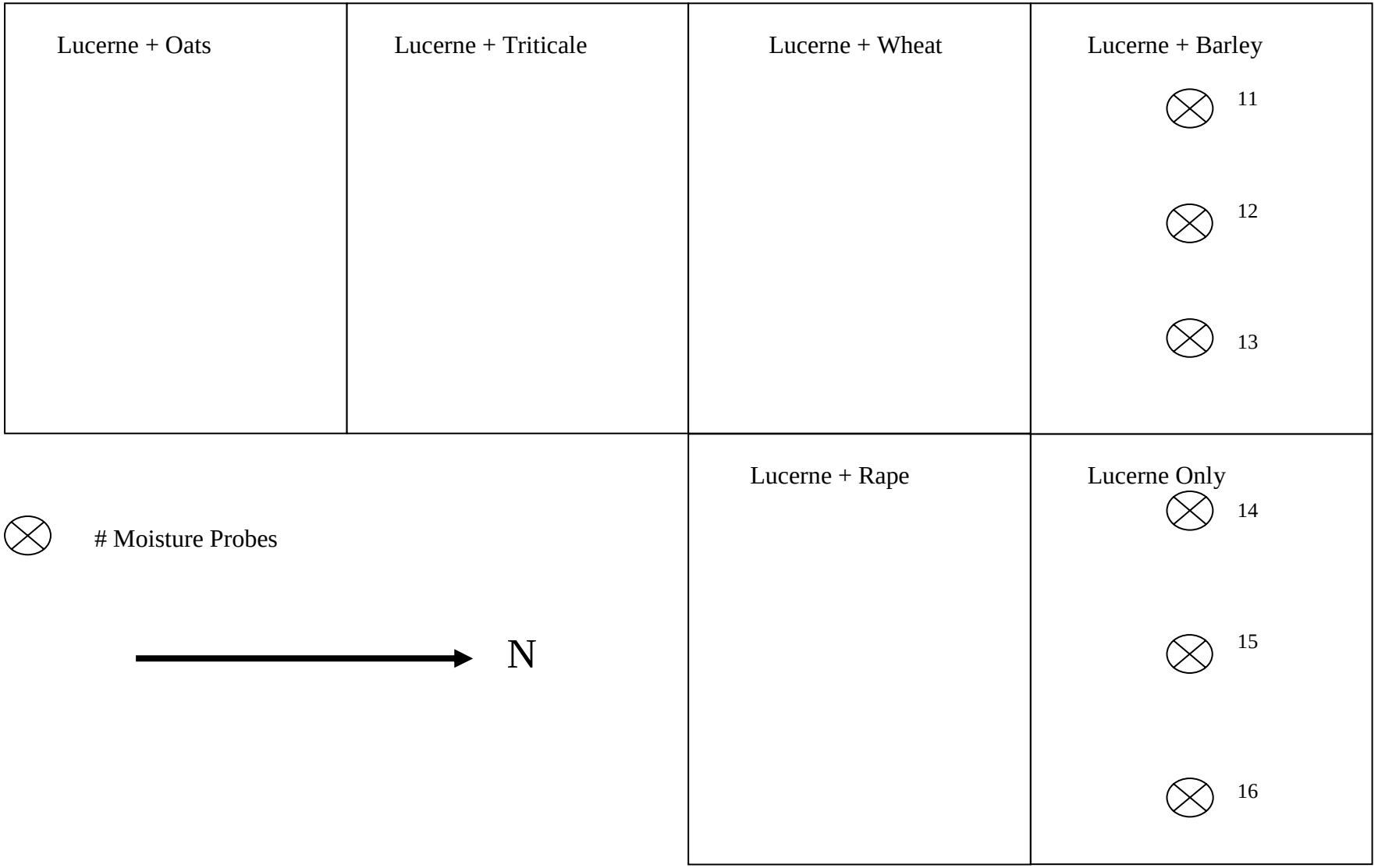
Soil moisture
Appendix 3 and 4 indicate there is little difference in the soil moisture extraction profiles between the lucerne plus barley and the lucerne only treatment. Plants growing in a cool winter climate use little moisture through transpiration. It is not until increasing temperatures and day length through spring and summer that transpiration increases. In this trial the winter active cereals were removed through targeted grazing pressure in early October and were therefore not present when these conditions prevailed. It is therefore understandable that the winter active cereals, although contributing significantly to production did not actually use much soil moisture in the process.

Likewise a careful examination of production trends through November and December (figure 1) shows that they are very similar for both the lucerne alone and the lucerne plus cereals. This indicates that both of these treatments were slowing in production due to moisture stress at about the same time. This can also be seen in appendix 3 & 4 where the onset of moisture stress occurs at a similar time in both treatments.

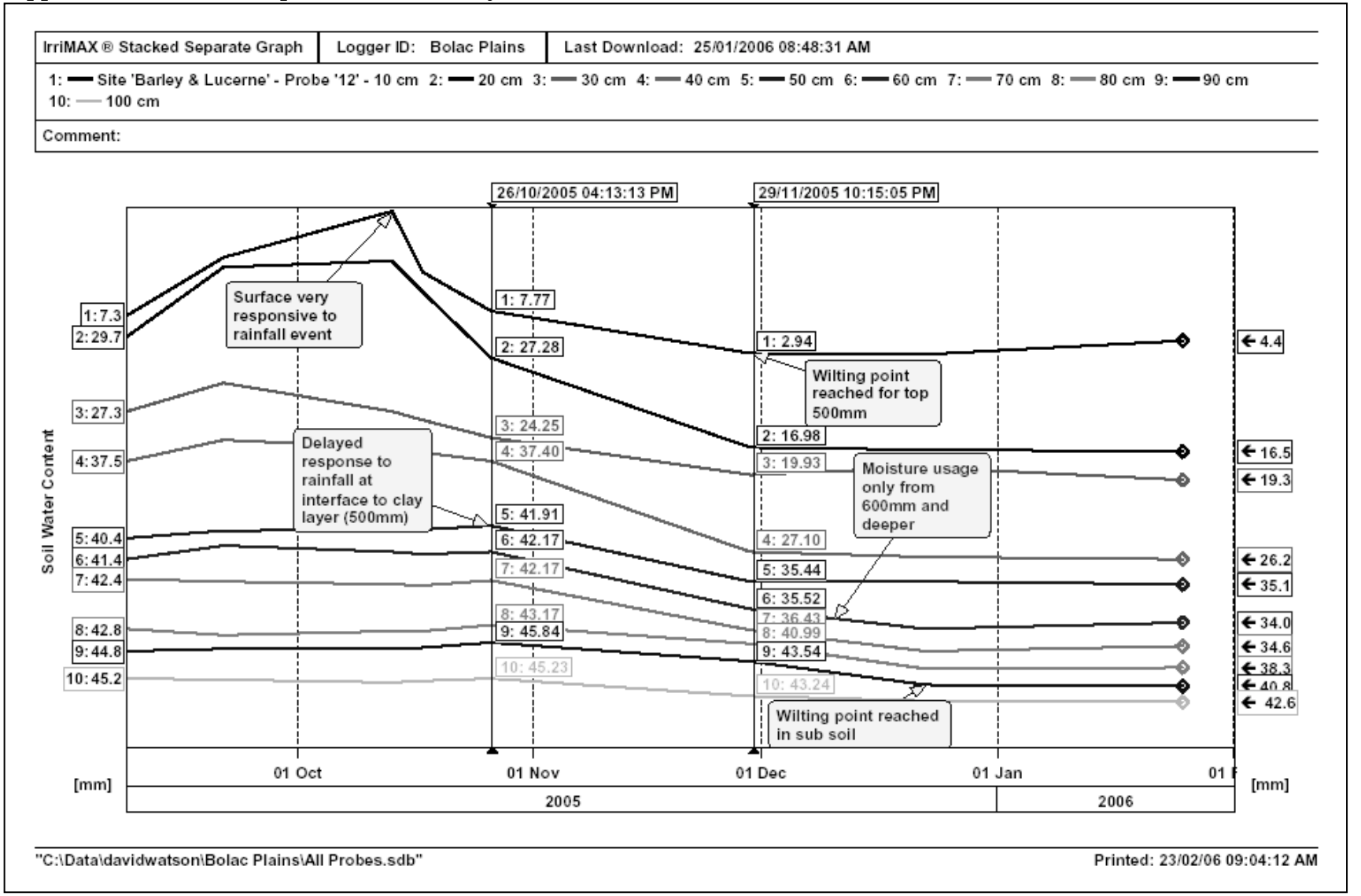
Season 2005
As mentioned earlier 2005 was a very dry year at *Bolac Plains* with a late autumn break that prevented early sowing. It would be expected that dry matter production (and profitability) of these treatments would increase significantly in a year with more normal rainfall patterns that allowed for earlier sowing.

Thanks
David Jamieson has committed significant personal and farm resources to this trial from which many people should benefit and he should be commended for it.

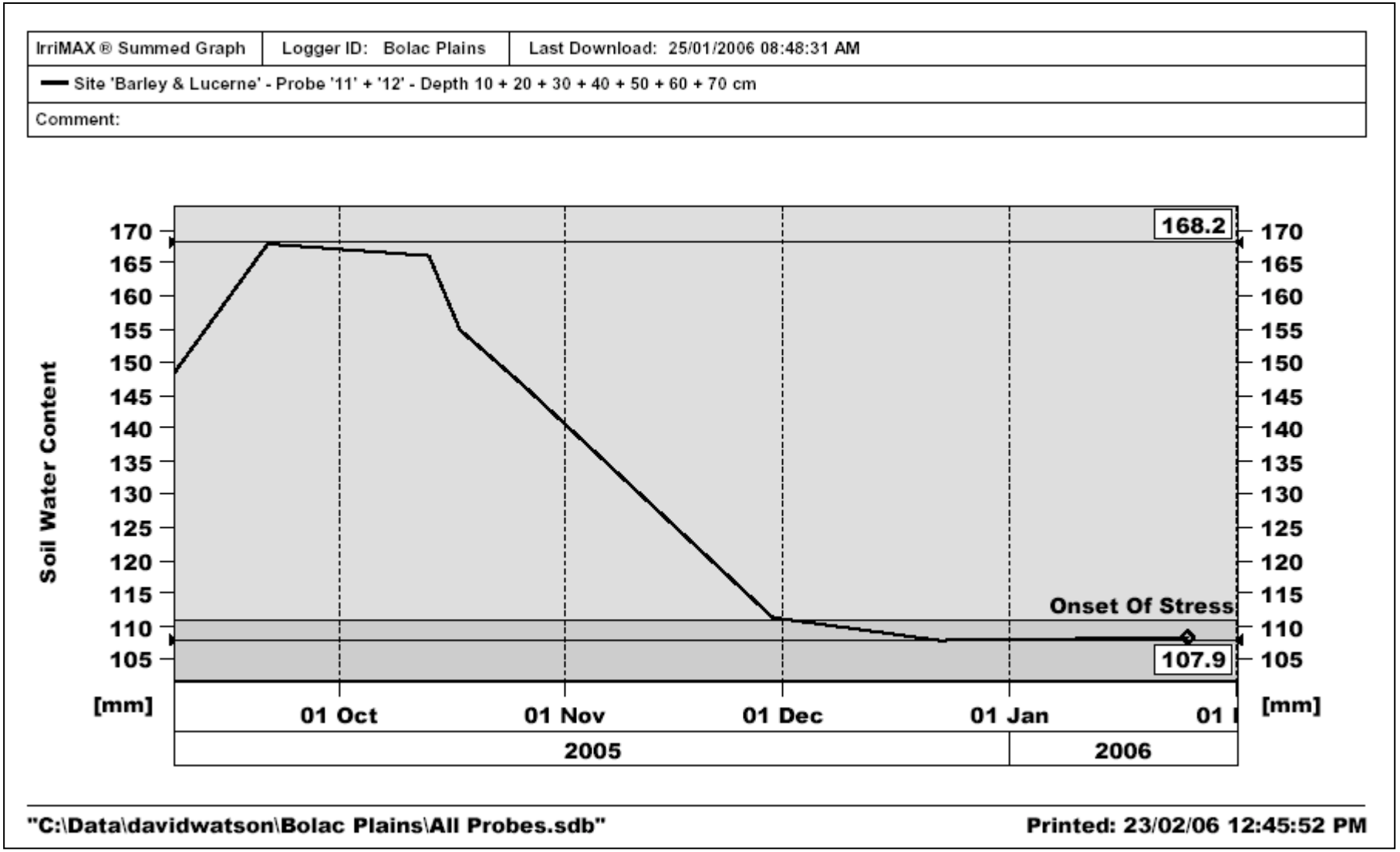
Appendix 1, Trial Layout



Appendix 2, Stacked Graph, Probe 12, Barley & Lucerne

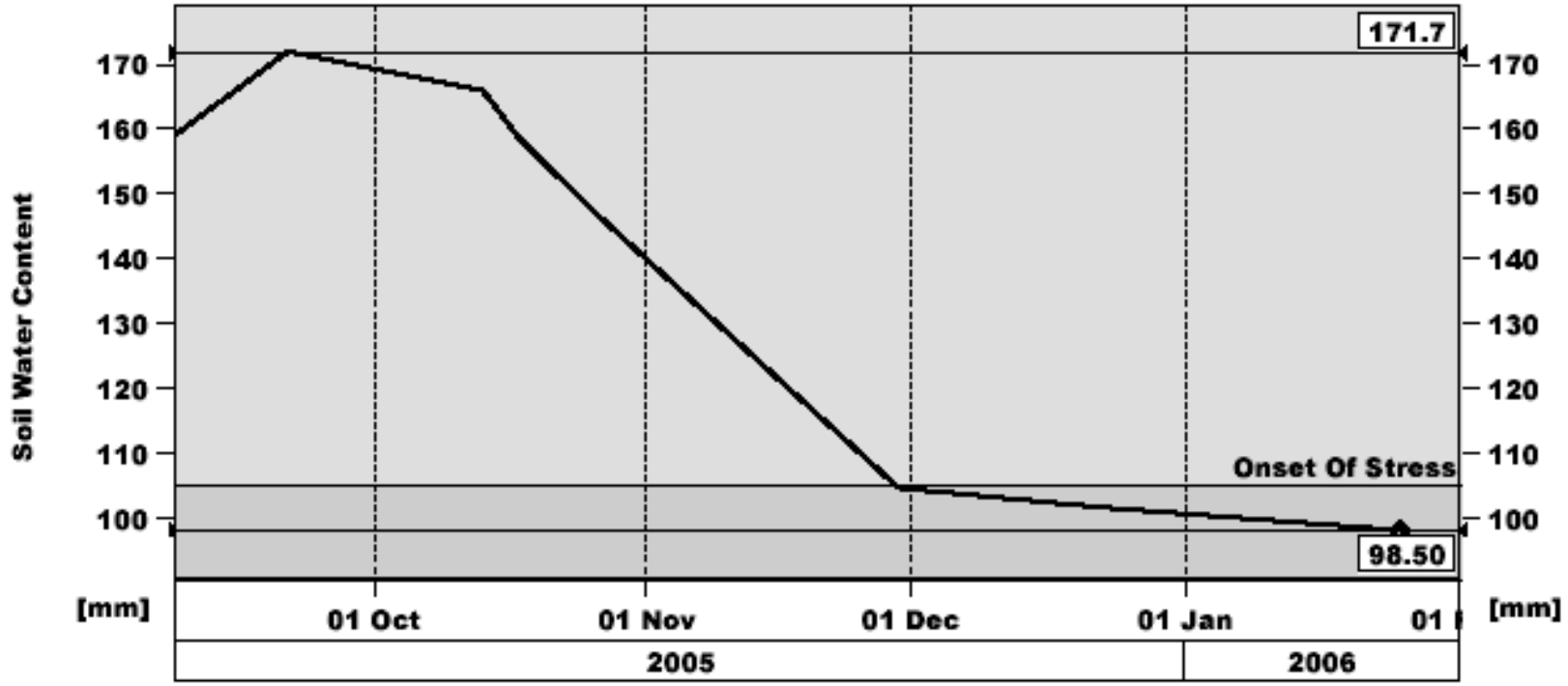


Appendix 3, Summed Graph, Lucerne and barley



Appendix 4, Summed Graph, Control (Lucerne only)

IrriMAX ® Summed Graph	Logger ID: Bolac Plains	Last Download: 25/01/2006 08:48:31 AM
Site 'Lucerne (Control)' - Probe '15' + '16' - Depth 10 + 20 + 30 + 40 + 50 + 60 + 70 cm		
Comment:		



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