Livestock in no-till cropping systems in the Mallee and Wimmera

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Take home messages

- **light to moderate grazing of sheep on no-till stubbles in autumn is unlikely to have detrimental impacts on crop growth in the following season.**

Background

Over the last decade, no-till farming systems have been widely adopted across northern Victoria. At the same time, there has been a general move away from livestock. In part, this is due to a perception among farmers adopting no-till that it is incompatible with livestock. There may have also been a need to simplify other aspects of their farm as they adapted to a major change in the cropping enterprise (adoption of no-till). Some no-till farmers may now be interested in reintroducing livestock. This project aimed to measure the effects of modest livestock grazing in a no-till cropping stubble, and any effects (positive or negative) on the following crop.

There is a variety of perceived problems with livestock in no-till farming systems including trampling, compaction, infiltration, erosion, poor feed production, weed seed burial and transport, surface roughness and livestock tracks from water points.

Potential benefits from livestock include increased profit from utilising residual feed resources, greater flexibility in weed control, reduced risk from price variation and poor seasons, alternatives to herbicide via integrated weed management, nutrient cycling and germination stimulation.

This study, which investigates the impact of livestock in no-till farming systems, is one component of the Northern Victoria GRDC Grain & Graze 2 project and will continue until 2013.

Aim

To investigate the effects of grazing livestock in no-till paddocks on soil structure, soil compaction and soil moisture, weed seed burial and carbon/nitrogen cycling in no-till farming systems.

Method

Sites

The study used no-till paddocks which were cropped in 2010 and 2011and had no livestock history in this time. A no-till, clay-loam paddock was selected in the Wimmera (Banyena) and a sandy-loam was chosen in the Mallee (Ultima).

Treatments

Three livestock exclusion zones were fenced off. Treatments were described as ‘grazing’ (paddock outside exclusion zone) and ‘control’ (inside exclusion zone).

Three replicates were established (the lowest possible number). More replicates would be desirable, but this work was relatively expensive (each had to be fenced). The approach taken instead was to increase the accuracy of measurements by taking multiple samples, and to balance sampling across both sides of the treatment (effectively six replicates). The interpretation accordingly notes differences that are significant at a lower p-value than commonly used ($P=<0.1$).

Grazing commenced when required by the farmers after harvest. Farmers were requested to stock paddocks at realistic rates for as long as possible, consistent with erosion and/or other management concerns, so that grazing treatments provided as much of a contrast as possible to control treatments.

All weeds were controlled in grazing and control treatments to eliminate water use as a factor in differences between treatments.

Measurements

Stubble residue was collected pre-grazing and pre-sowing (eight per treatment). Crop biomass samples were obtained at GS30, GS65 and GS99 (eight per treatment).

Surface soil bulk density (0-6.5cm and 5-11.5cm) and surface dry soil aggregation (0-1cm) were measured pre-grazing, pre-sowing and after harvest.

Soil surface and deep soil cores (eight per treatment) were taken pre-grazing, pre-sowing and after harvest. Composite samples at 0-10, 10-40, 40-70, 70-100 and 100-130cm depths were analysed for soil water and mineral nitrogen. Samples from 0-10cm were analysed for Colwell P.

Weed growth was described whenever the site was visited and validated by photographs.

The degree of weed seed burial in grazing and control treatments was estimated using proxy weed seeds (6mm plastic beads). Two 1m square areas in each treatment were hand 'seeded' at 400 seeds/m^2 prior to sheep grazing. Immediately after sheep were removed and post sowing, areas of row and inter-row were excavated (8.5cm x 30cm) in 1cm layers to 4cm. Soil from each layer was washed away over a fine sieve and the number of beads counted.

Yield, harvest index and quality analyses were undertaken at harvest.

Location:	Ultima
Paddock history:	four years of direct drilled cropping (no sheep)
Treatments:	grazing (81ha outside exclusion zone)
	control (15x20m fenced exclusion zones)
Replicates	3 exclusion zones
Stocking rate:	118 cross bred lambs
Stocking duration:	four weeks (12 April to 12 May)
Sowing date:	23 May 2011
Seeding density:	150 plants/m^2
Crop type/s:	Gairdner barley (2011), wheat (2010)
Seeding equipment:	Direct drilled (35.6cm row spacing)

Location:	Banyena
Paddock history:	4 years of direct drilled cropping. No sheep.
Treatments:	Plus Grazing (50ha bulk of the paddock)
	Control (15x20m fenced exclusion zones)
Replicates	3 exclusion zones.
Stocking rate:	180 cross bred ewes.
Stocking duration:	four weeks (17 March to 18 April)
Sowing date:	Early May 2011
Seeding density:	160 plants/m^2
Crop type/s:	Correll wheat (2011), canola (2010)
Seeding equipment:	direct drilled (30.5cm row spacing)

Results

Grazing effects: stubble

Grazing treatments in 2011 led to modest increases in stubble biomass measured at Banyena and Ultima (Figure 1). This is probably because it was easier to separate stubble from soil after grazing than in control plots. The main impact on measured stubble biomass was the sowing process and breakdown over winter, leading to a loss of about 200g/m^2 (2t/ha) at both sites.

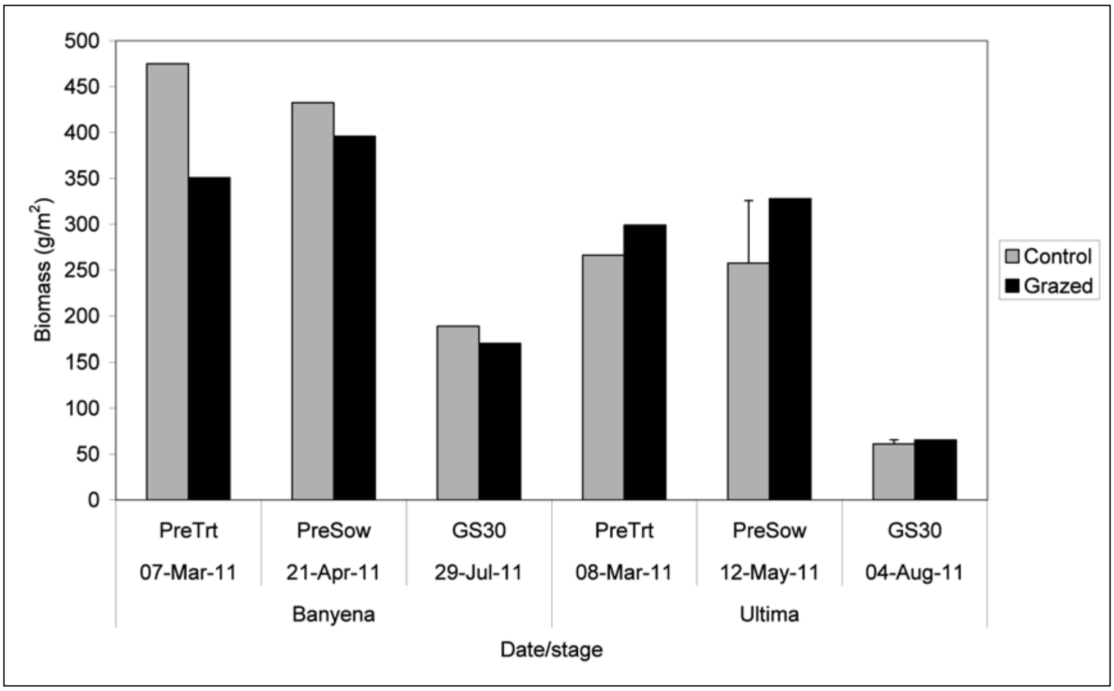

Figure 1. Stubble biomass before (PreTrt) and after grazing (PreSow), and at GS30 in the following crop. Error bars are least significant differences (P=<0.05) where P<0.05 (PreSow Ultima) and P=0.057 (GS30 Ultima)

Grazing effects: soil

Soil effects were measured as bulk density, aggregation, soil water and nutrients.

At both sites, bulk density measurements were lower pre-grazing (March) than pre-sowing and after harvest (Figure 2a, b). This could be related to differences in operators/method. At Banyena, grazed treatments had lower 0-6.5cm bulk density pre-sowing and higher bulk density post-sowing, but neither difference was significant. At Ultima, grazed treatments had higher bulk density for 0-6.5cm and 5-11.5cm, although this was only significant for 5-11.5cm in the pre-sowing (May) measurement.

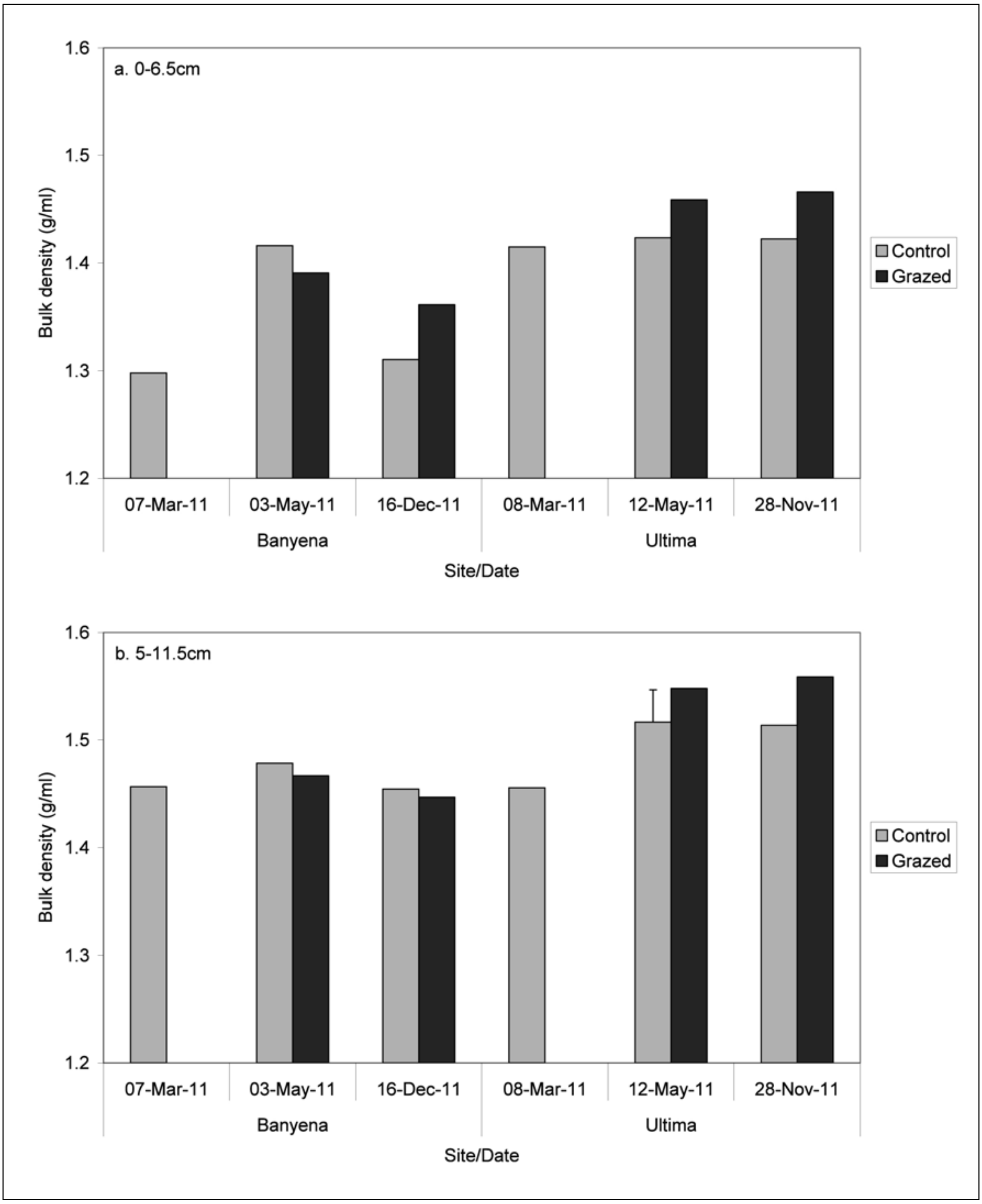

Figure 2. Bulk density in control and grazed areas pre-grazing (March), pre-sowing (May), and at crop maturity (November), for the (a). 0-6.5 and (b) 5-11.5cm soil layers. Least significant difference (P=0.05) is shown for significant treatments

Soil Aggregation

There were no significant differences in surface soil aggregation between grazed and control treatments (Figure 3). Differences between treatments were much smaller than differences between times of measurement.

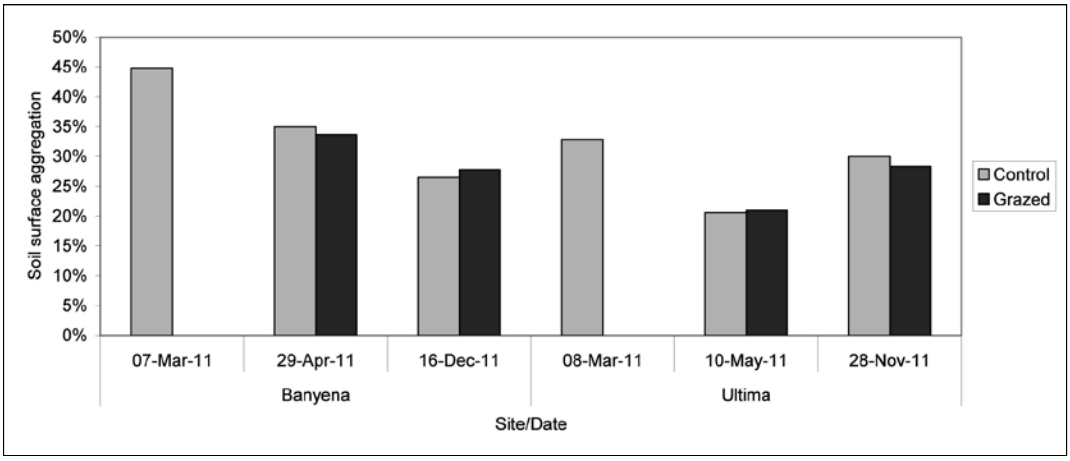

Figure 3. Soil surface (0-1cm) aggregation pre-grazing (March), pre-sowing (April/May) and post-harvest (November/December) at Banyena and Ultima. No differences were significant

Soil water

There was no consistent pattern to soil water differences between grazed and control treatments. At the surface, soil water was very similar for all treatments but significantly higher in the control treatment after harvest at Banyena (Figure 4a). In the root zone (10-70cm), soil water was higher in the grazed treatment at Banyena pre-sowing (Figure 4b). At Ultima in the root zone and for both sites for 70-100cm, soil water in the control treatment was always slightly higher. This was most likely due to spatial variation.

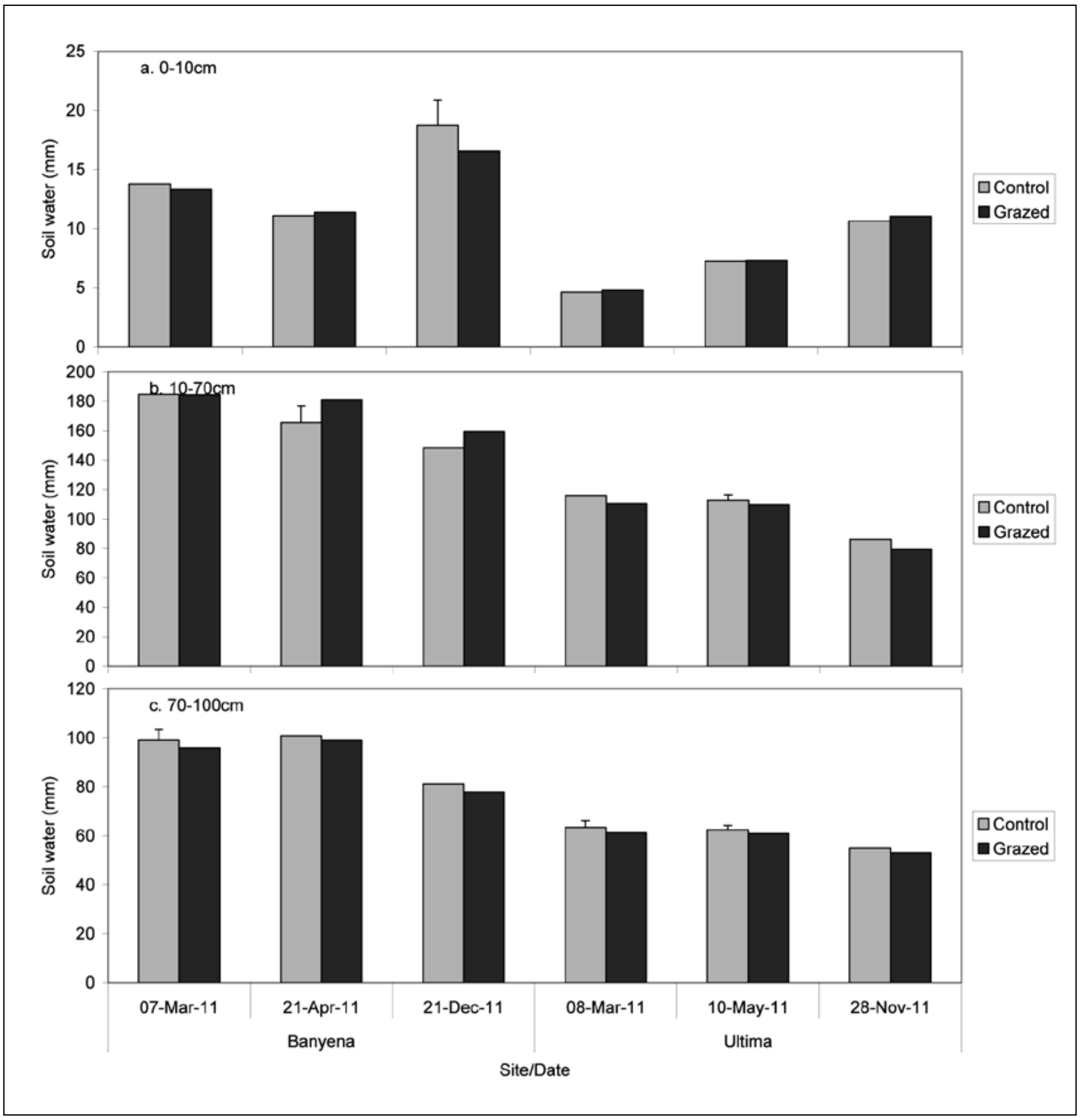

Figure 4. Soil water in control and grazed areas pre-grazing (March), pre-sowing (April/May), and post-harvest (November/December), for (a) 0-10, (b) 10-70 and (c) 70-100 cm soil depths. Error bars show least significant difference (P=0.05) for significant and near-significant (p<0.1) comparisons.

Soil nutrients

Soil nitrate nitrogen differed little between control and grazed treatments in surface soil (Figure 5a, 0-10cm), but did increase between pre-grazing and pre-sowing measurements. In 10-70cm soil, the grazing treatment was associated with a large increase in nitrogen at Banyena (Figure 5b), but it was not significant (a decrease in one replicate). At Ultima soil nitrate nitrogen in 10-70cm soil increased for both the grazed and control treatments between pre-grazing and pre-sowing measurements. In 70-100cm soil there was little difference between treatments at Banyena, and a large (but not significant) decrease in nitrate nitrogen in the grazed treatment at Ultima (Figure 5c).

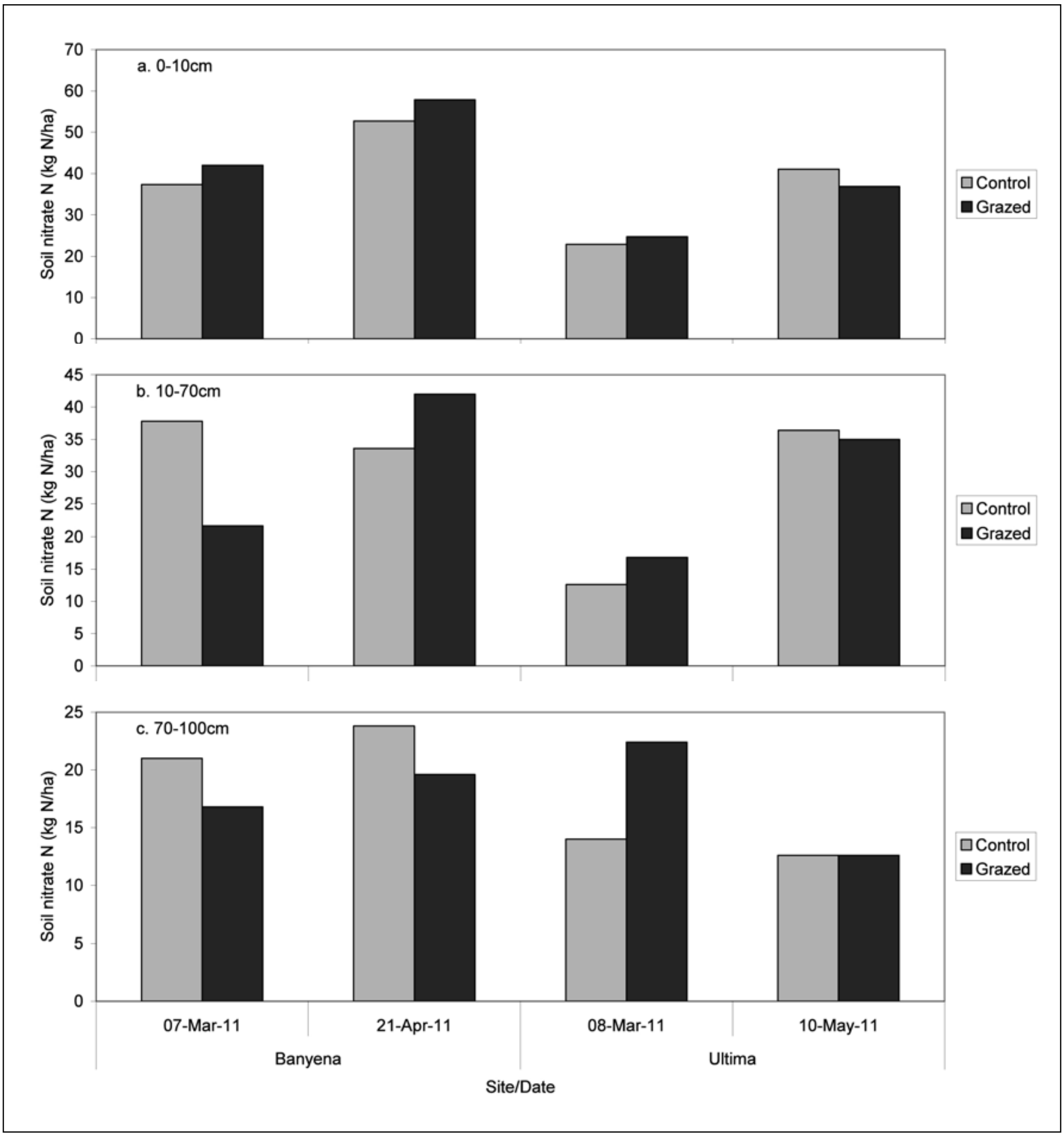

Figure 5. Soil nitrate (mineral) nitrogen in control and grazed areas pre-grazing (March) and pre-sowing (April/May), for (a) 0-10cm, (b) 10-70cm and (c) 70-100cm soil depths. No differences were significant

Colwell phosphorus levels were increased slightly by grazing in both treatments (Figure 6), but not significantly (even when data from both sites was pooled).

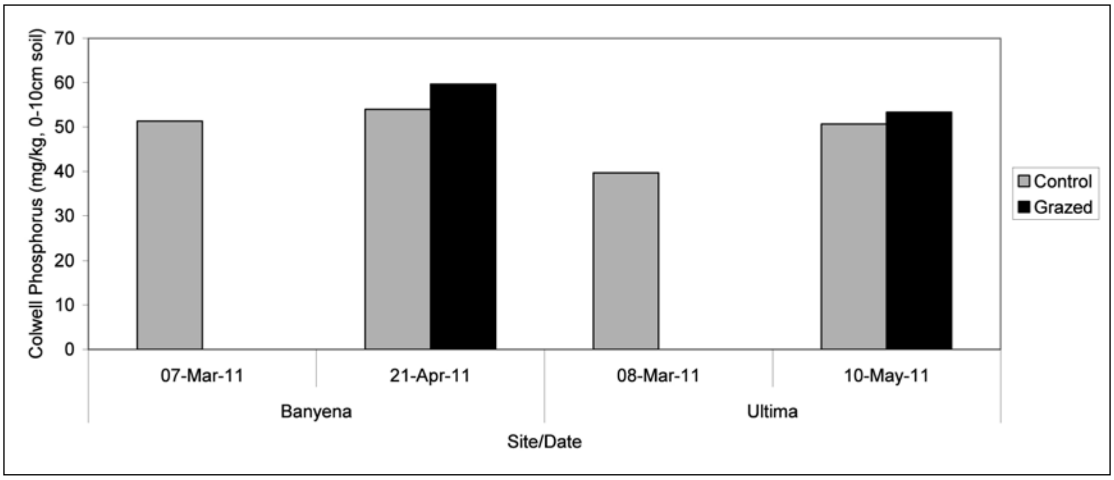

Figure 6. Soil Colwell phosphorus in control and grazed areas pre-grazing (March) and pre-sowing (April/May). No differences were significant. Mean phosphorus buffer index (PBI) values were 83 for Banyena and 153 for Ultima before grazing

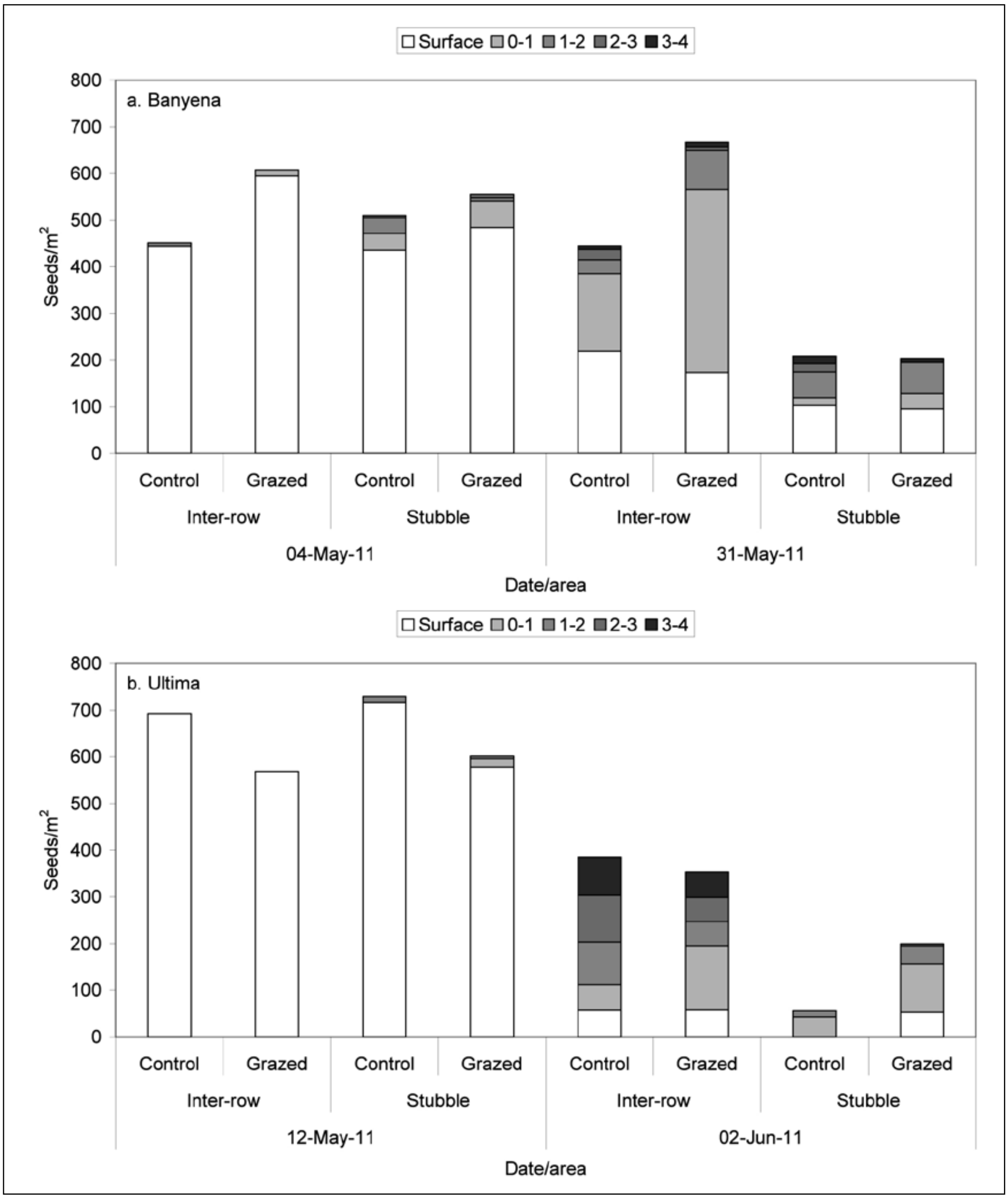

Figure 7. Fate of proxy weed seeds spread on the soil surface pre-grazing at Banyena (a) and Ultima (b), pre and post sowing and in the inter-row and at the base of previous crop stubble. Seed spread was measured at 1cm increments from the soil surface (surface, 0-1, 1-2cm etc.). None of the differences was significant at P=<0.05.

Grazing effects: weeds

The effects of grazing on weed seed burial were monitored using small beads, which were spread on the soil surface before treatment. Beads were much more difficult to recover in the 2010 stubble rows after sowing (few were recovered compared with those measured before sowing; Figure 7a, b) at both sites. Recovery was better from grazed areas at Banyena, especially in the inter-row after sowing, but it is difficult to see how this relates to the grazing treatment itself and any likely implications (the level of burial was similar). The fate of unrecovered beads is unknown. No differences were significant.

Crop growth

There was little difference in crop biomass between grazed and control treatments at any stage (Figure 8). Biomass nitrogen percent tended to be slightly higher in controls at the GS30 measurement, and lower later at GS65 and GS99, although it was only near-significant at Banyena at GS65, and the reverse pattern at GS99 at Banyena (Figure 9).

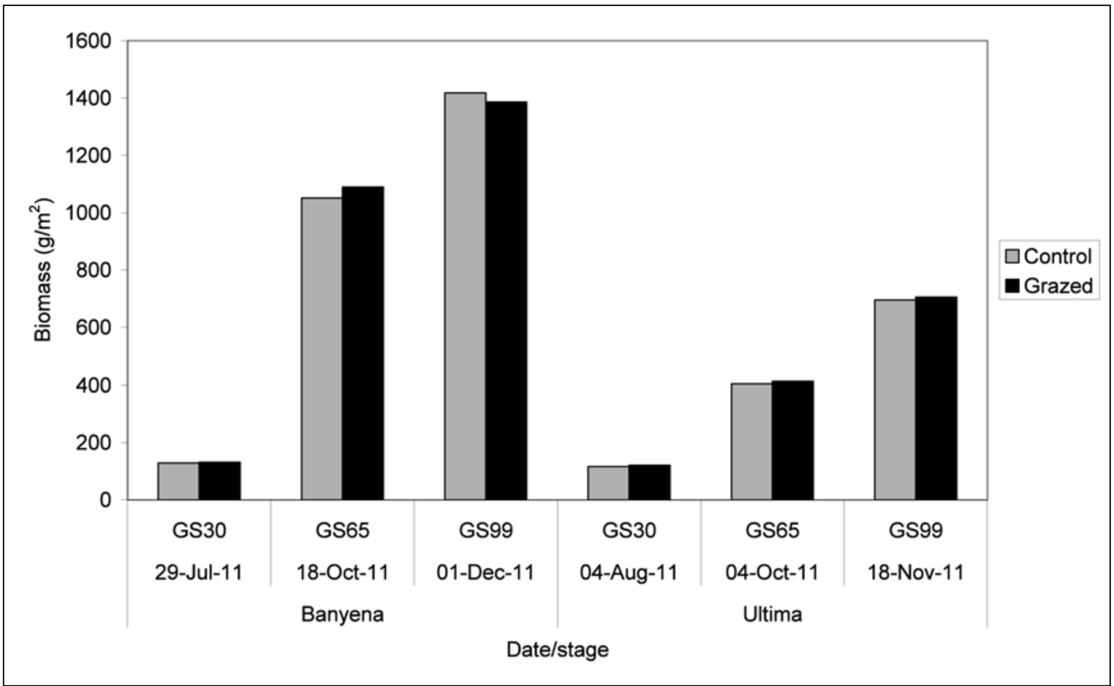

Figure 8. Crop biomass for control and grazed areas at Banyena and Ultima at GS30, GS65 and GS99. No differences were significant.

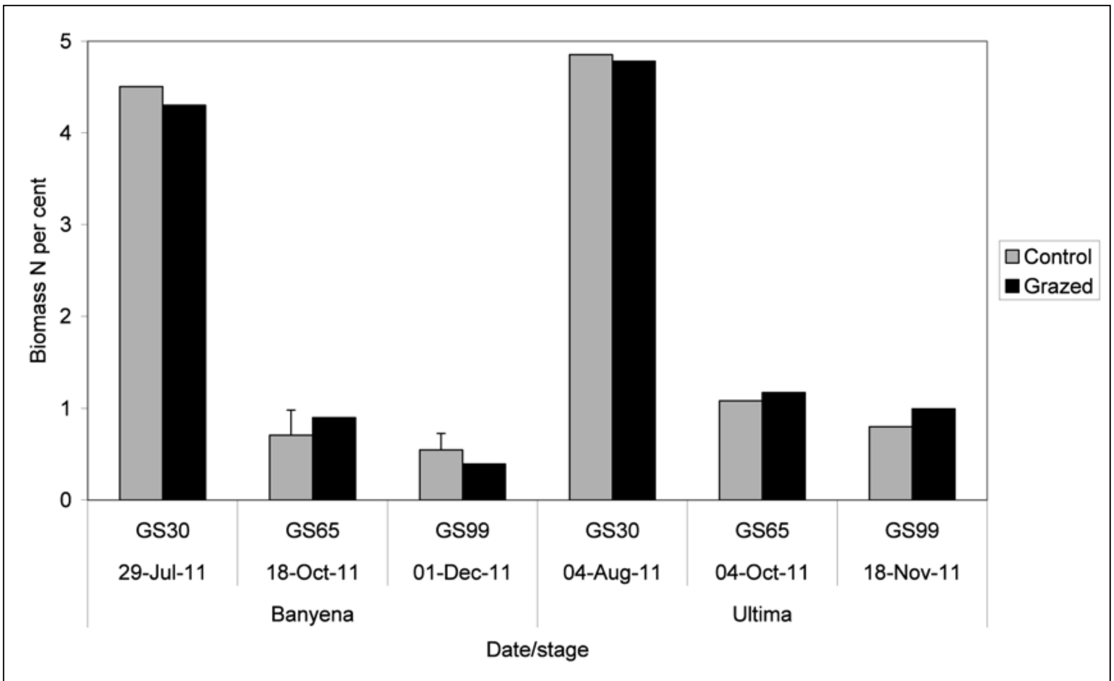

Figure 9. Crop biomass N per cent for control and grazed areas at Banyena and Ultima at GS30, GS65 and GS99. Least significant difference for p=0.05 is indicated by error bars, although the significance of these treatments is p<0.1.

There were no significant differences between crops grown on control and grazed treatments in terms of yield, harvest index or quality (Table 1). Most measurements were extremely close for both treatments and the difference was often much less than the experiment was capable of measuring.

Table 1. Grain yield, harvest index, protein and screenings for wheat at Banyena and barley at Ultima.

Site	Treatment	Yield (t/ha)	Harvest Index (g/g)	Protein (%)	Screenings (%)
Banyena	Control	5.02	0.353	9.47	0.32
	Grazed	4.97	0.358	9.00	0.28
Ultima	Control	2.97	0.426	9.36	3.48
	Grazed	3.03	0.429	9.43	1.57

Interpretation

Light-moderate grazing pressure by sheep on no-till stubbles in a paddock in the Wimmera and Mallee in late autumn led to a slight increase in surface (0-6.5 and 5-11.5cm) bulk density on the Mallee soil, but otherwise no measurable differences in soil surface aggregation or soil water. There may have been some effects on nitrogen nutrition in the root zone, but these had no measurable, relevant impact on crop growth, yield or quality, at yield levels that would be considered favourable in both areas. There were no consistent and/or measurable effects of grazing on burial of proxy weed seeds (plastic beads).

This initial (single season) work on grazing of no-till paddocks implies that grazing does have effects on soil properties. Unless grazing is particularly heavy, it is likely to be difficult to measure the effects both on soil properties and on crop growth. This needs to be confirmed again in the 2012 experiments.

Light to moderate grazing is also likely to be far less important in crop growth than factors such as rotation and weed control. The exception will be in situations in which the risk of erosion is high.

Commercial practice: what this means for the farmer

This is only the first year of work for this project, but results so far suggest that light-moderate grazing of sheep on no-till stubbles in autumn is unlikely to have detrimental impacts on crop growth in the following season.

Farmers need to consider erosion risk, and possible detrimental effects in paddocks in which there is a large weed seed bank before deciding to graze individual paddocks.

Acknowledgments

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