Pasture-cropping in a *Bothriochloa macra* (red grass) dominant pasture with a low input history

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Abstract. *Pasture-cropping is an innovative farming system combining livestock and crop production where winter cereal crops are sown directly into perennial pastures. Research results on a* Bothriochloa macra *(red grass) pasture indicate that while pasture production during the cropping phase can be depressed, overall spring biomass is increased. Recovery of ground-cover and pasture production to the level of an uncropped pasture occurs within 3–12 months of the cropping phase. Crop yields from pasture-cropping are dependent on good soil fertility, weed control and soil moisture; all of which are influenced by paddock history and pasture composition.*

Introduction

Pasture-cropping is an innovative farming system where winter cereal crops are sown directly into perennial pastures. Generally, the crops are sown into summer-growing native perennial pastures, such as red grass (*Bothriochloa macra*), after the first frost in autumn when these species become dormant. This is done to utilise the differential growth phases between the annual crop and the perennial grasses (Figure 1). Pasture-cropping can improve year-round resource use increasing overall annual productivity compared with conventional annual cropping or pasture alone (Howden *et al.* 2005). Improved profitability is dependent on efficiently utilising additional forage to compensate for reduced crop yield that can occur. In addition, costs are limited as fallowing is not required and fertiliser input can be matched to available soil moisture at sowing. However, perennial grasses growing through summer may prevent the accumulation of nutrients and water, which can affect crop performance.

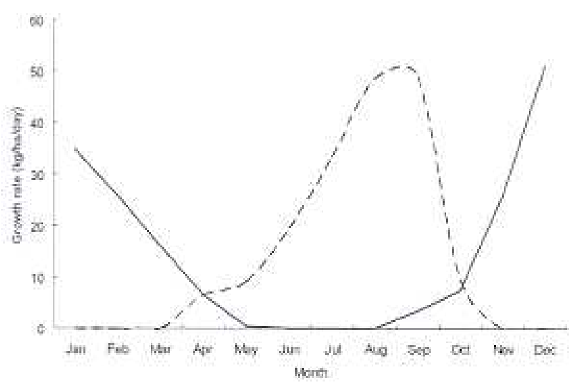

Figure 1. The average growth rate of C3 annual (crop or pasture, dashed line) and C4 summer growing grasses (solid line) for Wellington from 1998 to 2004 (SGS Pasture Model, www.imj.com.au/sgs).

Methods

This research project was based at the NSW Department of Natural Resources, Wellington Research Station (WRS) from 2005 to 2008. The aims of the experiment were to determine the success of pasture-cropping compared to no-till cropping and pasture treatments, and to determine the effect on resource use by a pasture-cropping system.

The trial area was set up on a red grass dominated perennial pasture. It is important to note that this research was carried out at the extreme of pasture condition as pasture-cropping is usually practised in paddocks with lower plant density and higher fertiliser history than in the red grass pasture studied here.

Core treatments were set up on the same plots for each of the three years of the experiment: continuous pasture (PA) with no fertiliser or herbicide, a no-till (NT) crop with a glyphosate treated summer fallow, and pasture-crop (PC) which was treated with Sprayseed® prior to sowing. All crops were sown with 60 kg/ha of wheat (cv. Ventura), in one pass to minimise soil disturbance. NT had 100 kg DAP fertiliser/ha (18N: 20P: 0K: 1.5S) at sowing, PC had 50 kg DAP/ha, while and additional treatment PC100 had 100 kg DAP/ha at sowing. As well, the trial had PC in different rotations with PA:

PC/PA/PA – one year PC, followed by two years PA

PA/PC/PA – one year PA, followed by one year PC, followed by one year PA

PA/PC/PC – one year PA, followed by two years PC

PA/PA/PC – two years PA, followed by one year PC.

Plot size was 18 m x 50 m (0.09 ha per plot), with three replicates per treatment. Measurements on all plots included plant composition and biomass, ground-cover, perennial grass recruitment in autumn and crop yields.

Soil fertility (nitrate) and moisture measurements were made on the core treatments only.

Results

Seasonal conditions

Rainfall was above average in 2005 due to substantial rain in the second half of the year, but the late 'break' delayed sowing until 24 June 2005 (Table 1). 2006 was an extremely dry year with only 302 mm of rainfall, of which 71 mm fell in the crop growing period (sown 22 June 2006) and crops were grazed instead of harvested. In 2007, rainfall was above average from April to June (sown 25 May 2007), but substantially below average for the remainder of the crop growing season.

Pasture production and demography

Pasture cropping increased overall spring biomass compared to pasture alone treatments in 2005 and 2007 (Figure 2). During the cropping phase, red grass was reduced in PC compared to PA, but it returned to similar levels to that in PA in the first summer after completion of cropping, except during the dry conditions of summer 2006/07. Red grass was effectively removed in NT by 2006. While ground-cover dropped dramatically during cropping, in the second summer after pasture cropping ceased, ground-cover recovered to values recorded for PA.

There was no difference among treatments in the total number or basal area of red grass plants at the start of

Table 1. Monthly rainfall 2005–2007 (mm) and mean annual (1946–2004) rainfall (mm) for Wellington Research Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2005	39.1	41.9	26.6	7.0	0.9	102.4	61.0	37.6	114.7	85.3	113.6	38.0	668.1
2006	40.6	81.6	14.2	20.8	1.0	29.0	51.8	9.6	6.4	3.2	13.2	30.8	302.2
2007	13.4	31.2	75.0	50.0	74.6	122.2	22.6	29.4	1.0	0.0	80.0	147.8	647.2
Mean	64.8	60.1	50.6	43.6	48.1	40.3	46.6	49.1	44.3	63.6	57.1	49.9	617.9

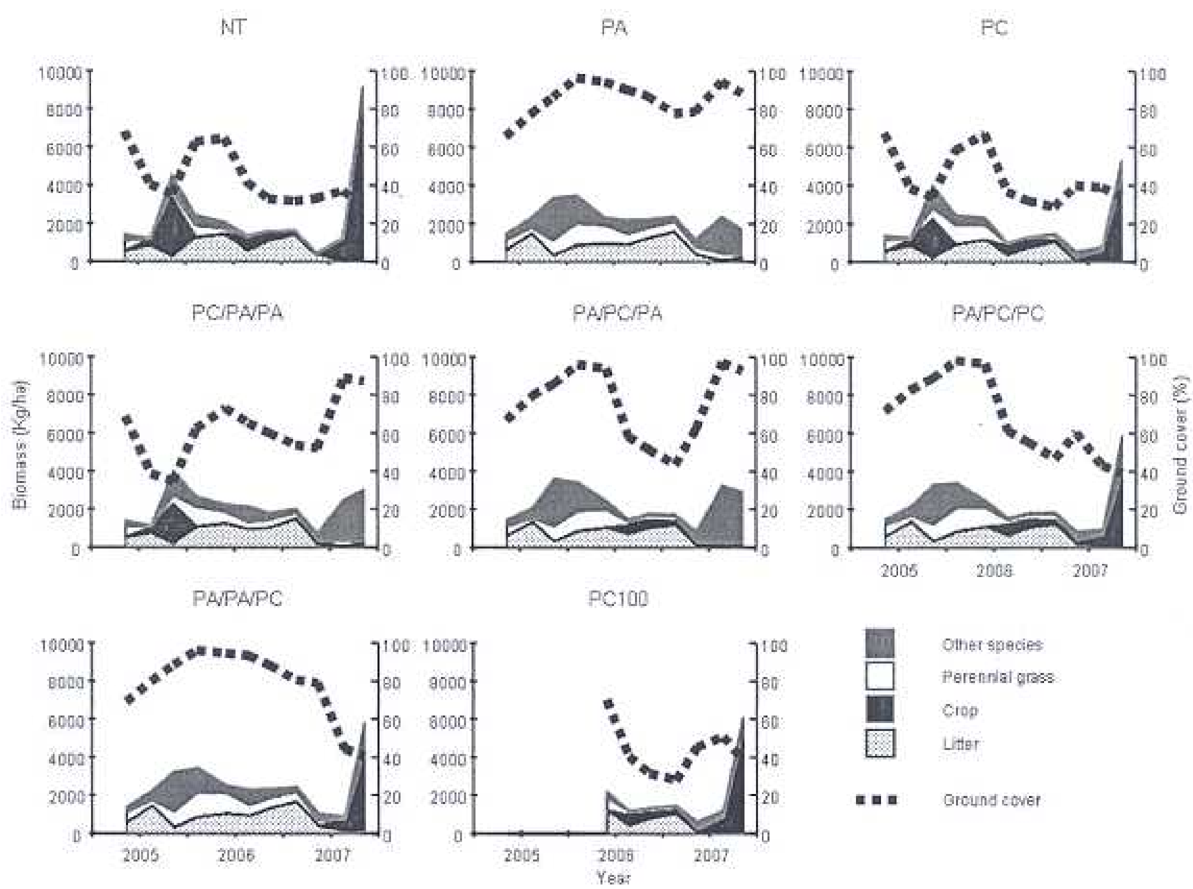

Figure 2. Mean biomass (kg/ha) and ground cover (%) of perennial grass, other species, crop and litter for all treatments.

Table 2. Total plants, adult plants and new seedlings recorded in PA and PC treatments (in autumn). Shading of cells within each year indicates treatment was pasture-cropped the previous year. Within each year, values with different letters are significantly different.

Year	Sig.	PA	PC	PC/PA/PA	PA/PC/PA	PA/PC/PC	PA/PA/PC
				Total plants/m²			
2005	ns	30	28	27	19.7	23.7	24.3
2006	ns	28.7	26.5	23.8	30.3	26.7	27.3
2007	ns	25.7	23.9	29.4	25.6	32	26.3
				Adults/m²			
2006	0.047	27.3 b	22.0 ab	14.0 a	14.3 a	21.0 ab	22.3 ab
2007	ns	22	14.7	15.3	11.3	16.3	22.7
				Seedlings/m²			
2006	ns	3.8	5.9	10.6	13	4.8	4.4
2007	0.034	6.3 ab	10.7 abc	15.0 c	11.0 abc	14.8 c	3.1 a

the trial in 2005 (prior to sowing). Red grass plants were completely removed from NT by 2006 but were retained at similar levels in PC and PA (Table 2). There was a decreasing number of adult plants over time (2005: 25.4, 2006: 20.2, 2007: 17.1; lsd (P=0.05) = 4.1). In 2007, there was an increase in the number of seedlings in pasture-cropped treatments compared to PA and PA/PA/PC treatments, but results were not consistent.

Crop yield

There was a higher yield in NT for all three years (Table 3). There was very little effect of DAP level at sowing on PC crop and biomass yields (PC vs. PC100), with little difference between continuous PC and PC in different rotations (PC and PC/PA/PA in 2005 were effectively the same treatment).

Soil fertility

There was a substantial difference in the level of nitrate in the top 10 cm of the soil between treatments prior to sowing in 2006 and 2007, with highest levels found in NT and lowest in PA (Table 4). PC had similar levels to PA in 2006 and NT in 2007. Nitrate measured to a depth of 100 cm in winter 2007 showed a similar gradient, which was most apparent between a depth of 30 and 80 cm. There was a strong relationship between crop yield and available N in the top 10 cm of the soil across all treatments in 2005 (mineral N at sowing plus N added in fertiliser; R^2 = 0.95). Also, multiple regression analysis with nitrate 0–10 cm and 10–80 cm accounted for 81 per cent of the variation in crop yield across all treatments in 2007.

Table 4. Nitrate (mg/kg) measured prior to sowing at 0–10 cm (2005–2007) in PA, PC and NT

Treatment	2005	2006	2007
PA	8.8	8.2	23.7
PC	9.5	10.5	40.0
NT	10.9	35.0	52.0
lsd (P<0.05)	ns	10.7	13.7

Soil moisture

No significant differences were observed in soil moisture between the core treatments.

Conclusions

Pasture-cropping increased overall spring biomass compared to pasture. While pasture cropping reduced red grass production during the cropping phase, it recovered to that for pastures during the non-cropping phase. Ground-cover after one year of pasture cropping recovered to levels observed in pasture the following

Table 3. Crop (2005 and 2007) and biomass (2006) yields (t/ha) for the cropped treatments (P<0.001). Least significant differences (P=0.05) are indicated

year	lsd (P=0.05)	NT	PC	PC100	PA/PA/PC	PA/PC/PA	PA/PC/PC	PC/PA/PA
2005	0.13	1.73	1.11					1.25
2006	0.15	1.63	0.60	0.69		0.61	0.58	
2007	0.44	2.68	1.37	1.51	1.30		1.35	

year. Results for perennial grass recruitment were inconclusive, while crop yields from pasture cropping were dependent on good soil fertility, weed control and soil moisture. No differences in soil moisture usage were detected due to the lack of rain over the summer and autumn period.

Acknowledgements

Pasture-cropping research was funded by the Central-West/Lachlan Grain & Graze program.

References

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