Sheep liveweight production from lucerne, cocksfoot or ryegrass based pastures

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Abstract

Sheep liveweight (LW) production and total annual DM yields of four dryland cocksfoot (CF) based pastures (sown in combination with subterranean (Sub), balansa (Bal), white (Wc) or Caucasian (Cc) clovers); a perennial ryegrass (RG)/white clover control pasture and a lucerne (Luc) monoculture were compared for five growth seasons (2003-2008). Stock were managed to optimise production from each pasture type in each season and this included continuous and rotational grazing. Annual LW production from lucerne (833-1110 kg/ha/y) was superior to all grass based pastures in three of the five years largely due to similar spring but superior summer animal and crop production. Over five years, spring LW production was the most consistent and, averaged over treatments and years, represented 64% of total annual LW production. In contrast, LW production over summer months was variable and accounted for 15-33% of total annual LW production. Generally, LW production was low when summer rainfall was below average (<142 mm) and higher when summer rainfall was average or above. Autumn production was 2-4% of annual LW production after a productive (moist) summer and 17-26% after a dry summer. Of the grass based pastures, LW production was greatest from CF/Sub due to superior spring growth, particularly in Years 2, 3 and 5. Overall, the results indicated a range of pasture species were required in dryland systems to cope with seasonal and annual variability in rainfall.

Key Words

sheep liveweight production, seasonal production, dry matter yields, *Dactylis glomerata, Lolium perenne, Medicago sativa, Trifolium balansae, T. ambiguum, T. repens, T. subterranean.,*

Introduction

In temperate regions there is widespread use of perennial ryegrass/white clover pastures. Their productive ability under a range of environmental and grazing regimes makes them ideal where adequate rainfall or irrigation is available. However, problems with production and persistence in dryland areas (Fraser, 1994) necessitate alternative pastures to meet stock demand. This is particularly important on the east coast of New Zealand where rainfall ranges from 350 to 1000 mm/y. One option is lucerne as a specialist forage which produces greater yields and hence higher LW production in summer than grass based pastures due to greater water extraction from deeper in the soil profile than shallower rooted species (Brown et al. 2005).

The second most commonly sown pasture grass in New Zealand is cocksfoot which has been shown to be more productive and persistent than perennial ryegrass in dryland environments. It is usually included as a component of dryland pasture mixes but over time it can become dominant. Its aggressive behavior towards companion legumes, particularly white clover, results in a reduction in clover content over time and cocksfoot then becomes nitrogen deficient. It has previously been shown that nitrogen limits cocksfoot productivity under both irrigated and dryland conditions (Peri et al., 2002, Mills et al., 2006).

The use of annual clovers, such as subterranean or balansa, as companion legumes may increase early spring production and quality of available feed. For these clovers, life cycles are completed in late spring and, unlike white clover, they do not compete with cocksfoot for water and nutrients in dry summer months. In contrast, the perennial taprooted summer active Caucasian clover has been suggested as a suitable companion legume for cocksfoot based pastures (Black and Lucas, 2000). White clover was also included in the current experiment because it is usually included in mixes containing cocksfoot or is resident as seed in most New Zealand soil.

Methods

Design and treatments

Six pastures were established as small farmlets (22 x 23 m) with a randomised complete block design (RCB) and four replicates in 2002. Pastures included cocksfoot established with subterranean (CF/Sub), balansa (CF/Bal), white (CF/Wc) or Caucasian (CF/Cc) clovers, a perennial ryegrass/white clover (RG/Wc) control and a lucerne (Luc) monoculture. An additional two replicates were established in 2004 as reported by Brown et al. (2006).

Environmental conditions

Figure 1 shows seasonal rainfall and mean air temperature, from the Broadfields Meteorological Station located 2 km north of the experimental area, compared with long-term (LTM) seasonal means (1975-2002) for spring (Jul-Nov), summer (Dec-Feb) and autumn (Mar-Jun). Annual rainfall totalled 490-681 mm.

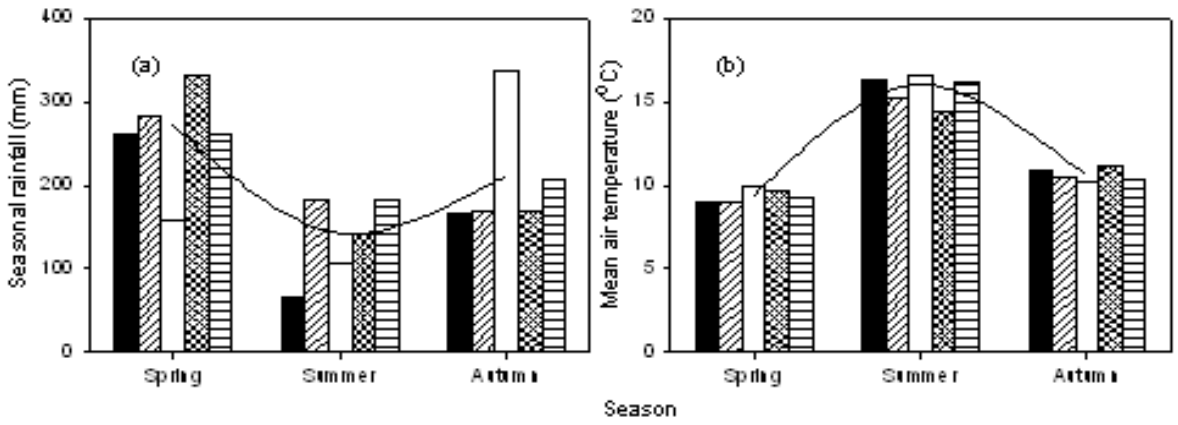

Figure 1. Seasonal (a) rainfall (mm) and (b) mean air temperature (°C) in 03/04 (■), 04/05 (▨), 05/06 (□), 06/07 (▩) and 07/08 (■) at Lincoln University, Canterbury, New Zealand. Solid lines are long-term seasonal means (1975-2001).

Measurements

(a) Liveweight gain

A 'put and take' system of grazing was employed which included 'core' and 'spare' animals. Further information on grazing management was reported previously (Brown et al., 2006). Briefly, 'core' animals were weighed 'empty' after being held overnight in a stock yard before and immediately after grazing periods of 3-6 weeks. Pastures were de-stocked over winter (Jun-Aug) except for ewes used to clean up pastures in preparation for the subsequent spring. Seasonal LW production was separated into 'spring', which included production grazing events between Jul-Nov, 'summer' between Dec-Feb and 'autumn' from Mar-Jun. Hoggets were put on plots in spring and removed when lambs were available post-weaning in late spring/summer. The total number of grazing days, and number of grazing days associated with LW production are shown in Table 1. Averaged over five years, 72-94% of total grazing days were associated with production periods and ranged from a minimum of 52% in CF/Bal pastures in Year 4 to 100% in Lucerne (Years 3 and 5).

Table 1. Total grazing days/ha (Total) and production (P) grazing days/ha which contributed to LW production. Difference indicates the number of grazing days annually for maintenance stock.

	2003/04		2004/05		2005/06		2006/07		2007/08	
Pasture	Total	(P)	Total	(P)	Total	(P)	Total	(P)	Total	(P)
CF/Sub	1650	1251	2042	1958	2150	1830	2556	1714	2066	1647
CF/Bal	1770	1035	2504	1770	2115	1856	2823	1467	1930	1557
CF/Wc	1678	1363	2339	2114	1973	1731	2526	1678	2022	1602
CF/Cc	1688	1280	2099	1921	2047	1832	2793	1799	2184	1674
RG/Wc	1536	1274	1926	1747	1616	1390	2590	1617	1782	1385
Luc	1527	1424	1687	1545	1394	1394	1879	1600	1614	1448

(b) Annual DM yield

In grass based pastures, dry matter (DM) production was measured from a 0.2 m^2 quadrat, taken from exclosure cages. Regrowth duration was extended when pastures were exposed to water or temperature restrictions. DM production of lucerne stands was measured by cutting 5 x 0.2 m^2 quadrats from each plot on the day of grazing.

Analysis

Annual DM production (Jul-Jun) was calculated from the sum of yields from individual regrowth cycles. Liveweight gain data for individual grazing periods was calculated as a weighted mean seasonal growth rate which allowed analysis of seasonal LW production by least squares regression using Genstat 10. Significant means were separated by Fishers protected LSD at $\alpha = 0.05$.

Results and Discussion

Liveweight Production

Lucerne produced the greatest liveweight (Figure 2) in three years (2003/04, 2004/05 and 2006/07), when it was 33-42% higher than any grass based pasture. In most years, the number of grazing days on lucerne was lower than grass based pastures (Table 1) but the superior average daily liveweight gain compensated for this. For example, in spring, hoggets on lucerne averaged 260 g/hd/d compared with 195 g/hd/d for RG/Wc and 160-180 g/hd/d for cocksfoot based pastures. In summer, the lambs grazing lucerne averaged 160 g/hd/d compared with only 65 g/hd/d for RG/Wc and 90 g/hd/d for cocksfoot based pastures, which resulted in 45-200 kg/ha more LW production. The superior animal production from lucerne pastures in summer, especially in 2005/06 and 2007/08, corresponded with below average summer rainfall (Figure 1). Lucerne yields ranged from 10.0-18.5 t DM/ha/y and produced >60% more DM annually than grass based pastures in 2004/05 and 2006/07 (Table 2).

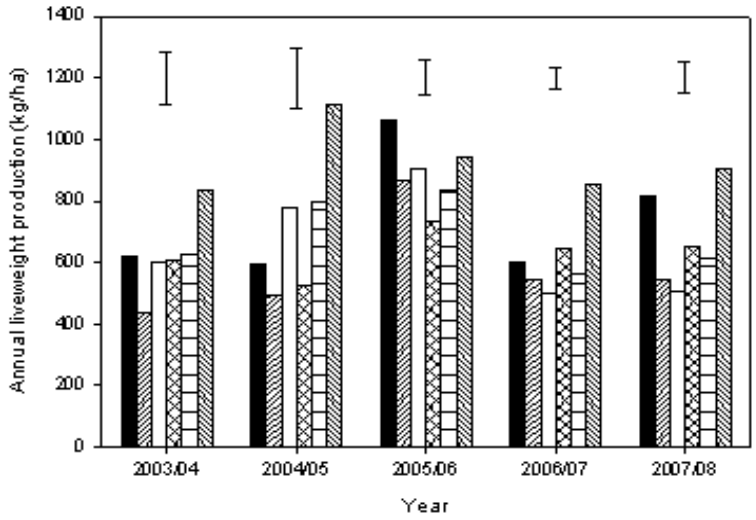

Figure 2. Total annual liveweight production (kg/ha) from dryland CF/Sub (■), CF/Bal (▨), CF/Wc (□), CF/Cc (▧), RG/Wc (▤) and Lucerne (▧) pastures at Lincoln University, Canterbury, New Zealand. Error bars are LSD at P<0.05 for each year.

Spring was the most reliable and productive season for all pasture combinations in all years. Averaged over five years, spring accounted for 64% of annual LW production (Figure 3a) and 40-63% of total annual DM yields. Of this, 36-77% was from the sown grass and 3-52% from the clover. For the grass based pastures, spring LW production (355-760 kg LW/ha) from the CF/Sub pasture was superior, or equal, to the next best performing pasture in four out of five years. In most years, spring production from the CF/Bal pastures (252 and 599 kg LW/ha) was lower than CF/Sub. Annual LW production from white clover with cocksfoot or perennial ryegrass was similar in four out of five years, due to similar seasonal production. Over time the performance of the CF/Cc pastures improved and it was the highest producing perennial legume based pasture in the last two years. This improvement reflected the increased total clover content, being Cc and volunteer white clover, from 8% in Year 1 to 35% in Year 5.

Summer LW production by grass based pastures was highly variable (Figure 3b) due to unreliable summer rainfall which ranged from 65 to 185 mm for the three months (Dec-Feb). In years with below average summer rainfall (<142 mm), LW production accounted for 15-18% of annual production but was >30% when rainfall was ≥142 mm. It appeared that pasture and animal production in autumn were influenced by summer rainfall (Figure 3c). Specifically, LW production following moist summers represented 2-3% of total annual production compared with 16-26% following a dry summer.

Overall, results suggest sub clover was the most suitable companion legume for cocksfoot. The addition of white clover may increase LW and DM production, particularly in moist summers. These species provide complementary spring and summer production for dryland farm systems that utilise lucerne as their major summer forage source.

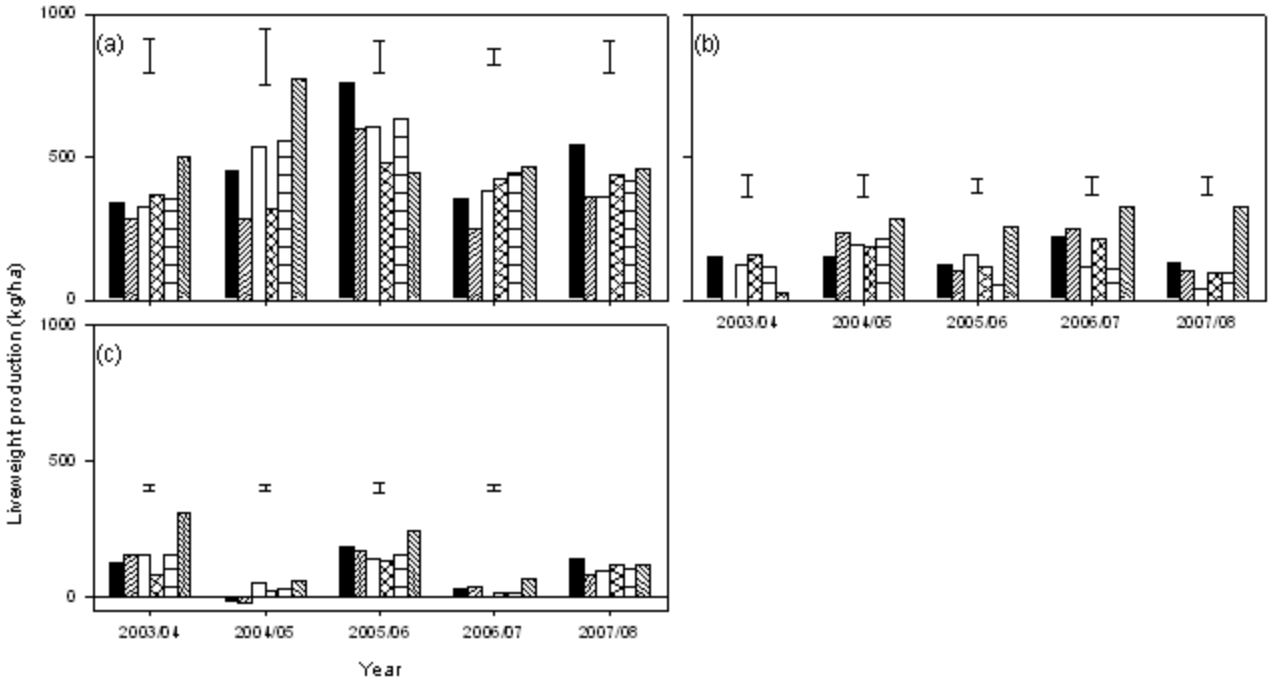

Figure 3. Seasonal liveweight production (kg/ha) in (a) spring (Jul-Nov), (b) Summer (Dec-Feb) and (c) autumn (Mar-Jun) from dryland CF/Sub (■), CF/Bal (▨), CF/Wc (□), CF/Cc (▩), RG/Wc (▣) and Lucerne (▧) pastures at Lincoln University, Canterbury, New Zealand. Error bars are LSD at P<0.05 for each year.

Table 2. Total annual DM yield (t DM/ha/y) for dryland CF/Sub, CF/Bal, CF/Wc, CF/Cc, RG/Wc and Lucerne pastures at Lincoln University, Canterbury, New Zealand.

	Year				
Pasture	2003/04	2004/05	2005/06	2006/07	2007/08
CF/Sub	10.4 $_{b}$	11.1 $_{b}$	11.5 $_{a}$	10.0 $_{bc}$	11.2 $_{b}$
CF/Bal	11.5 $_{ab}$	10.0 $_{bc}$	9.4 $_{bc}$	8.4 $_{d}$	7.5 $_{cd}$
CF /Wc	10.5 $_{b}$	11.2 $_{b}$	8.5 $_{cd}$	9.7 $_{bc}$	7.1 $_{d}$
CF/Cc	8.3 $_{c}$	9.0 $_{c}$	8.0 $_{d}$	10.8 $_{b}$	9.0 $_{c}$
RG/Wc	8.4 $_{c}$	10.1 $_{bc}$	9.1 $_{bcd}$	9.4 $_{cd}$	8.8 $_{c}$
Luc	13.1 $_{a}$	18.5 $_{a}$	10.0 $_{b}$	17.4 $_{a}$	14.0 $_{a}$

Grand mean	10.3	11.6	9.4	10.9	9.6
SEM	0.54	0.60	0.48	0.43	0.57
Significance	***	***	***	***	***
LSD	1.63	1.76	1.38	1.25	1.67

Note: Significance levels are: ns=non significant, * =0.05, **=0.01 and ***=0.001. Treatment means followed by the same letter subscript are similar at the P<0.05 level.

Conclusions

- In three of the five years lucerne pastures gave superior total LW production and total DM yield.
- Over a five year period, CF/Sub has given the most consistent spring LW production of the grass based pastures.

A combination of pastures was required to ensure LW production was maintained in different seasons and across years due to variable rainfall.

Acknowledgements

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