The effect of pasture species on pasture and animal performances in irrigated systems.

R.A. MOSS[1], T.J. FRASER[2], M.J. DALY[2], T.L. KNIGHT[2] and D.G. CARSON[1]
[1]*AgResearch, Winchmore Research Station, Private Bag 803, Ashburton*
[2]*AgResearch, PO Box 60, Lincoln*
[1]mossr@agresearch.cri.nz

Abstract

The effect of two contrasting forage supply options on forage and sheep production was evaluated on irrigated farmlet systems at Winchmore, mid Canterbury, over 3 years. One system was based on perennial ryegrass pastures (Control), and the other on hybrid ryegrass, tall fescue, and chicory pastures (Improved). Pasture growth rates were similar for all pasture types, however, pasture cover was on occasion, higher on the Control than Improved systems ensuring this system was self-sufficient in feed while the Improved system had a deficit averaging 714 kgDM/ha/yr. Swards on both systems contained similar proportions of legume but the Improved system contained less grass and more chicory before lamb grazing. Despite the apparent improvement in feed quality of the Improved system, its lamb performance was greater than that from the Control system for the first year only, when swards were newly established and contained greater proportions of chicory and legume. Although pasture production was similar between years there was considerable variation in lamb growth rates. This was most pronounced in the Improved system where pre-weaning rates averaged 266 and 216 g/d in years 1 and 3 respectively, and post-weaning rates 190 and 108 in years 1 and 2 respectively. The post-weaning variation appeared to coincide with fluctuations in clover and to an even greater extent, the chicory content of swards, the proportion of which declined as seasons progressed and pastures aged. The Improved system gave financial returns from lamb that were $49/ha higher than the Control in year 1 but offered no advantage in subsequent years. Compared to the Control, the Improved system had the added costs of more frequent pasture renewal and was further disadvantaged by a feed deficit necessitating buying-in supplies. Improvements anticipated to accrue from the inclusion of higher quality swards in an irrigated animal production system, were not supported by findings from this study.

Keywords: irrigation, lamb production, pasture production, pasture quality, pasture species

Introduction

A move towards the improvement of product quality (Brown 1996) and to the matching of market specifications (Manhire 1999) is essential for ensuring the future viability of the New Zealand sheep meat industry. A recommendation from the sheep industry has been to focus sheep forage research on improving lamb growth rates. This would offer greater flexibility to farmers and meat exporting companies to meet required market specifications in terms of supply and carcass grades.

This is the second paper in a series that relates to sheep forage systems research first reported in Fraser *et al.* (1999).

The "systems" approach used means that; (1) livestock performance was recorded, with the number of lambs meeting the predefined carcass criteria each year used for a between systems comparison; (2) pasture performance was recorded to assist in explaining how the treatments affected livestock and economic performance because seasonal forage supply and quality patterns were expected to differ between forage treatments; (3) system costs and returns were recorded to permit economic analysis. This paper reports on the first of these two approaches.

The primary objective of this experiment was to quantify the effect of two contrasting forage supply options on forage and sheep production in a systems context when managed in a summer moist situation.

Method

This experiment ran concurrently with the above-mentioned unirrigated systems. As both series had a largely common methodology it will not all be reported here as it was reported by Fraser *et al.* (1999).

Site

The experiment was located at the Winchmore Research Station in mid Canterbury on a Lismore stony silt loan. The design involved six farmlets (two forage supply systems each with three replicates). Each farmlet consisted of 12 permanent paddocks, with temporary subdivision available when required. Average paddock size was 0.42 ha, and total farmlet size was 5.04 ha.

Pastures

Two contrasting forage supply options were evaluated, one (Control) was based on perennial ryegrass (*Lolium perenne*) pastures, and the other (Improved) on a mixture of high quality pastures. The Improved forage supply option was designed to maximise lamb growth rates, but also offered potential benefits for ewe liveweight and wool production.

Improved farmlets contained three basic pasture types: hybrid ryegrass (*L. boucheanum syn L. hybridum*), tall fescue (*Festuca arundinacea*), and chicory (*Chicorium intybus*). The cultivars used for the Improved system were selected with the aim of optimising animal performance. The Improved treatment had four paddocks of nil-endophyte hybrid ryegrass and chicory pasture, five fescue, and three chicory and red clover (*Trifolium pratense*) paddocks. The 12 Control paddocks were based on high-endophyte perennial ryegrass pasture. All except chicory, were sown with white clover (*Trifolium repens*).

At the commencement, in autumn 1997, the Control pastures were 5 years old while for the Improved farmlets, new pastures were established on 10 of the 12 paddocks in the spring of 1996 and the remainder in February 1997. Within each farmlet, and within each forage type, one Improved and two Control paddocks were renewed annually. All pastures were irrigated by the border-strip method.

Animal management

Mixed-age Coopworth ewes, stratified for age and liveweight, were allocated to farmlets in late-March annually. They were mated to Suffolks commencing in early-April. Comparable ewe numbers were maintained between treatments continuously. Lamb numbers were adjusted during early lactation to give similar numbers of lambs/ewe between farmlets within years. This equated to 1.5, 1.7, and 1.5 lambs/ewe rearing, during spring 1997, 1998 and 1999 respectively.

Grazing management

Following allocation to treatments, ewes were rotationally grazed with the objective of feeding at rates sufficient to at least maintain liveweights. This pattern of feeding was maintained until the end of tupping (two cycles). After mating and during winter, ewes were block-grazed on a 70- to 100-day rotation with shifts every 2 days, using temporary electric fences to achieve the required feed rationing. Winter feed supplies were supplemented when required with hay or silage from a common source. Ewes and lambs were rotationally grazed from lambing to weaning after which lambs and ewes were rotationally grazed separately with lambs offered the best pasture available (3- to 5-day shifts), with ewes following.

Lamb husbandry and sales

Lambs were weighed at birth with ram lambs left entire. They were weaned at a mean age of 11 weeks. Lambs were drafted for slaughter (Table 1) at weaning and every 14 days thereafter until late March. Below-target lambs remaining at the last drafting date were removed as stores.

Table 1 Sheep performance targets for ewe and lamb systems on irrigated pastures at Winchmore.

	Target
Stocking rate	
Ewes wintered per ha	17.0
Ewe mating	
Liveweight (kg)	65
Start date	12 April
Lamb survival to sale (%)	160
Minimum target carcass weight (kg)	
Ram lambs	18.0
Ewe lambs	16.0
All lambs sold	end March
Minimum ewe weights	kg/head
February	60
Mating	65
Start of lambing	65
Weaning	65

Animal health

Internal parasite status was assessed by faecal worm egg counts. On the basis of these assessments, lambs were dosed anthelmintic post-weaning, once during 1997/98, twice during 1998/99, and three times in 1999/00. Copper, cobalt and selenium status was assessed by the OPTIGROW service from liver samples obtained at slaughter. These tests suggested a need for vitamin B12 supplementation which was done by injecting with Vitamin B12 on 3 December 1998. Copper and selenium levels were adequate as was B12 during the other 2 years. All pastures were topdressed with selenium annually.

Pasture measurements

Potential pasture growth from the four pasture types and overall herbage mass from each system was measured at monthly intervals using the methodology described by Fraser *et al.* (1999). Herbage botanical composition was measured from representative paddocks before lamb grazing post-weaning. Hay and silage made on the farmlets, and the amount fed, was assessed from bale number, weight and dry matter percentage.

Animal measurements

Liveweights are for unfasted animals. Wool was bulked within farmlets, before weighing. Lambs were sent for slaughter in farmlet mobs and carcass weight, grade and financial return from each farmlet recorded from the freezing works return sheets. The weight of lambs sold store was recorded and their financial worth calculated using a common value per kg liveweight.

Biometrical analyses

Each set of data was analysed using a two-way analyses of variance, with the mean value for each of the three farmlets per treatment as replicate blocks. All LSD values are at the 0.05 level of significance.

Table 2 Rainfall, number of agricultural drought days and irrigation requirements at Winchmore.

	April–May	Winter	Spring	Dec–March	12-month
Rainfall mm					
1997/98	117	157	127	187	588
1998/99	79	152	115	185	531
1999/00	47	250	202	305	804
50-year mean	127	187	172	249	735
Drought days					
1997/98	0	0	8	76	84
1998/99	11	0	19	87	117
1999/00	0	0	0	0	0
48-year mean	3	n r*	6	40	49
Irrigations					
1997/98	1	0	2	6	9
1998/99	1	0	2	7	10
1999/00	0	0	0	3	3

* n r = not recorded

Results and discussion

Climate

Years 1 (1997/98) and 2 (1998/99) followed similar climatic trends with lower than normal spring and summer rainfalls, resulting in more drought days than the long term mean. This resulted in a higher irrigation requirement (nine and 10 applications per year for years 1 and 2 respectively) than occurred in year 3 (1999/00, three applications), reflecting the higher than average rainfall in the latter year (Table 2).

Table 3 Mean pasture growth 1997–99 from irrigated pasture at Winchmore.

	kgDM/ha/d			
	Control	Improved		
	ryegrass	ryegrass	tall fescue	chicory
April and May 1997	17	20	14	12
June to August 1997	4	7	4	2
September to November1997	35	44	33	43
December 1997 to March 1998	49	44	49	59
April to May 1998	18	24	19	18
June to August 1998	5	5	5	3
September to November 1998	46	48	47	50
December 1998 to March 1999	43	42	41	43
April to May 1999	18	20	16	12
June to August 1999	5	8	6	5
September to November 1999	40	44	40	37
December 1999 to March 2000	54	58	47	55
	t DM/ha/yr			
1997/98	10.5	11.2	10.1	12.0
1998/99	10.9	11.3	10.9	11.0
1999/00	11.6	13.0	10.8	11.3
3-year mean	11.0	11.8	10.6	11.4
LSD 0.05	1.2			
Significance	ab[1]	a	b	ab

[1] means with letters in common are not significantly different (P<0.05)

Pasture performance

Pasture growth rates were similar for all pasture types across the two systems (Table 3). Growth rates ranged from a mean of 5 to 49 kgDM/ha/d during winter and summer respectively. Averaged across the 3 years, annual DM production differed significantly, with a mean DM production of 10.6 t DM/ha by tall fescue compared with 11.8 t DM/ha produced by the hybrid ryegrass (P<0.05).

The between-year variation in total DM production was small reflecting the benefits of irrigation during times of inadequate rainfall (Table 2). Pasture cover was higher on the Control than Improved systems during mid-winter and early spring at the commencement of lambing (Table 4). While pasture covers were similar across treatments during December, at lamb weaning and following herbage conservation, pasture covers were higher on the Control than on the Improved systems during March.

The lower mid-winter pasture cover on the Improved system resulted in a greater requirement for input of conserved feed (Table 5), despite which, covers were still lower than on the Control at lambing during September. Pasture covers on the control increased further during spring relative to those on the Improved system, resulting in considerably higher quantities being conserved on the Control during late spring.

All pasture types on both systems that were offered to weaned lambs contained, on average, a similar proportion of clover and dead matter (Table 6). The Control perennial ryegrass and Improved systems' tall

Table 4 Pasture cover at strategic feeding periods (kgDM/ha) in two irrigated systems under sheep grazing at Winchmore.

	Control	Improved	LSD 0.05	Significance[1]
June 1997	1015	694	87	**
September 1997	1509	1394	68	**
December 1997	2318	3037	479	*
March 1998	2623	2347	579	ns
June 1998	1258	1344	133	ns
September 1998	1893	2061	139	*
December 1998	3258	3071	286	ns
March 1999	2786	2562	319	ns
June 1999	2571	1878	367	**
September 1999	2399	1978	153	**
December 1999	2592	2396	447	ns
March 2000	2884	2536	121	**
3-year means				
June	1615	1305	968	ns
September	1934	1811	732	ns
December	2723	2834	1306	ns
March	2764	2482	155	*

[1] * = P<0.05; ** = P<0.01; ns = non-significant

Table 5 Supplementary feed balance (kgDM/ha) on two irrigated pasture systems at Winchmore.

	Conserved	Fed	Balance
1997/98			
Control	342	520	-178
Improved	272	799	-527
LSD 0.05	31	340	578
Significance[1]	ns	ns	ns
1998/99			
Control	348	612	-264
Improved	51	1071	-1020
LSD 0.05	323	493	629
Significance	ns	ns	*
1999/00			
Control	697	255	442
Improved	272	884	-612
LSD 0.05	629	255	714
Significance	ns	**	**
3-year mean			
Control	459	459	0
Improved	204	918	-714
LSD 0.05	442	459	918
Significance	ns	ns	ns

[1] * = P<0.05; ** = P<0.01; ns = non-significant

Table 6 Herbage composition before post-weaning lamb grazing (% component present) in four pasture mixes at Winchmore.

	Control ryegrass			Improved ryegrass			
	grass	clover	dead	grass	clover	chicory	dead
December–January 1998	55	20	17	25	26	32	13
February–March 1998	43	15	19	17	8	50	12
December–January 1999	59	12	19	38	15	29	10
February–March 1999	51	12	18	48	7	18	12
December–January 2000	66	10	13	51	10	11	14
February–March 2000	65	12	12	45	10	5	19
3-year mean	57	13	16	37	13	24	13
	Improved tall fescue			**Improved chicory**			
	grass	clover	dead	grass	clover	chicory	dead
December–January 1998	51	30	14	2	15	66	8
February–March 1998	65	11	14	15	8	62	9
December–January 1999	70	12	12	30	15	33	11
February–March 1999	53	8	24	30	8	21	21
December–January 2000	60	9	15	32	24	19	12
February–March 2000	60	6	21	35	14	15	15
3-year mean	60	13	17	24	14	36	13

fescue swards contained similar proportions of grass (57 and 60%), and clover (13 and 13% respectively). However, the hybrid ryegrass and chicory swards contained proportionately less grass (37 and 24%) and more chicory (24 and 36%) for hybrid ryegrass and chicory swards respectively than either the Control perennial ryegrass or Improved tall fescue. All swards contained a high proportion of clover, and where applicable, chicory, during year 1, when pastures were young, (mean age 5.0 and 0.8 years in year 1 and 4.9 and 2.0 in year 3, for Control and Improved respectively). The proportion of clover, and to an even greater extent, chicory, declined relative to grass during the following 2 years. In the chicory based swards, the proportion of chicory averaged 64% vs 17% during summer/autumn in years 1 and 3 respectively (Table 6).

During the spring, more herbage was conserved on the Control than the Improved system (Table 5), as a result of significantly greater pasture DM cover on the Control than the Improved pastures.

The Improved system required more conserved feed than did the Control resulting in the Improved system having an annual feed deficit, emulating the experience of Moss *et al.* (1998), when comparing “improved” swards with perennial ryegrass in irrigated systems. Averaged over the 3 years, there was no feed deficit on the Control but one of 714 kg DM/ha on the Improved system.

Animal performance

Liveweight performance of suckling lambs was similar across the two systems during the first 2 years. However, during year 3 the Control lambs grew significantly faster at this time than those on the Improved system, resulting in a 1.2 kg difference in weaning liveweight (Table 7).

Post-weaning liveweights were significantly higher for Improved lambs than Controls during year 1, however Control lambs tended to be heavier than Improved lambs post-weaning during years 2 and 3.

Considerable variation in the rate of liveweight gain was evident, both within and between years. Lambs grew most rapidly while suckling (3-year mean all treatments was 246 g/d), Moderate lamb growth rates were recorded immediately after weaning (152 g/d December to February), with relatively low growth rates recorded subsequently (131 g/d). The between-year variation was most marked in the Improved system with pre-weaning growth rates of 266 vs 216 g/d in years 1 and 3 respectively, and post-weaning rates of 190 vs 108 in years 1 and 2 respectively. The variation in post-weaning and between-year growth rate appeared to coincide with changed proportions of clover and clover and chicory in swards (Table 6) and may reflect the higher nutritive value of these species. (Konolong *et al.* 1992; Scales 1993; Scale *et al.* 1995; Knight *et al.* 1996). The proportion of clover and chicory declined as the study progressed, and was particularly marked in the Improved grass-based swards.

The proportion of the lambs reaching target drafting liveweights tended to be greater for the Improved than Control treatments, reflecting higher lamb growth rates in year 1 (Table 8). This trend was reversed in the following 2 years, although the difference was only statistically significant on one date. Similarly, 79 and 95% of the lambs were drafted in year 1 but only 33 and 27% in year 2, from the Control and Improved systems respectively.

Table 7 Lamb liveweight performance on two irrigated systems at Winchmore.

	Liveweight (kg)	Liveweight change (g/d)				
	at weaning 3/12/97	birth to weaning	weaning to 4/2/98	4/2/98 to 31/3/98	post-weaning	birth to 31/3/98
1997/98						
Control	26.7	270	153	135	145	204
Improved	26.4	266	191	185	190	229
LSD 0.05	2.1	26	19	76	23	22
Significance[1]	ns	ns	*	ns	*	ns
1998/99	2/12/98		weaning to 4/2/99	4/2/99 to 30/3/99		birth to 30/3/99
Control	23.2	245	124	111	118	167
Improved	23.7	253	121	93	108	164
LSD 0.05	1.4	16	40	46	26	16
Significance	ns	ns	ns	ns	ns	ns
1999/00	7/12/99		weaning to 2/2/00	2/2/00 to 29/3/00		birth to 29/3/00
Control	23.7	227	170	134	156	188
Improved	22.5	216	155	128	144	177
LSD 0.05	0.7	9	20	38	29	16
Significance	*	*	ns	ns	ns	ns

[1] * = P<0.05; ns = non-significant

Table 8 Lamb carcass production on two irrigated systems at Winchmore.

	Proportion of lambs reaching target weights (%)							
1997/98	6/1/98	21/1/98	4/2/98	18/2/98	4/3/98	17/3/98	31/3/98	Total
Control	5	3	12	4	17	26	12	79
Improved	9	14	17	16	19	15	5	95
LSD 0.05	12	6	19	13	17	17	16	13
Significance[1]	ns	*	ns	ns	ns	ns	ns	*
1998/99		21/1/99	4/2/99	17/2/99	3/3/99	17/3/99	30/3/99	
Control		2	1	2	9	11	8	33
Improved		2	1	4	7	12	1	27
LSD 0.05		4	1	6	12	17	3	18
Significance		ns	ns	ns	ns	ns	**	ns
1999/00	5/1/00	18/1/00	2/2/00	16/2/00	1/3/00	15/3/00	29/3/00	
Control	2	2	6	12	16	5	17	60
Improved	1	1	2	12	13	6	12	47
LSD 0.05	1	3	4	13	11	10	16	27
Significance	ns	ns	ns	ns	ns	ns	ns	ns

[1] * = P<0.05; ** = P<0.01; ns = non-significant

Despite carcass weights consistently reflecting the rate of post-weaning liveweight gain such that the faster growing lambs produced the heavier carcasses, differences were not statistically significant between the Control and Improved treatments (Table 9). There was a direct relationship between lamb growth rate, the proportion drafted, and income from lamb such that income was higher from the Improved than Control lambs in year 1 but not subsequent years. The financial advantage of $49/ha from the Improved treatment in year 1 is unlikely to adequately compensate for the greater cost of establishing and maintaining pastures in this system. The major components of the Improved swards (hybrid ryegrass, chicory, red clover) are recognised as having a considerably lower persistence than high endophyte perennial ryegrasses and therefore 25% of them were replaced annually compared with 16% of the perennial ryegrass Control swards, thus increasing the cost to the Improved system.

Forage supply system had no effect on ewe liveweights during the first 2 years (Table 10), however the Improved system ewes tended to be lighter than the Controls at weaning and in the following March in year 3. Ewe fleece weights were similar for both treatments at all shearing dates (Table 11).

It was hypothesised that the Improved system would result in superior animal performance compared with a high-endophyte perennial ryegrass-based system. The small differences in year 1 and absence of improved animal performance in years 2 and 3 were therefore contrary to expectations. When compared to high-endophyte perennial ryegrass, chicory has been shown by many workers to increase lamb liveweight gains in short-term grazing experiments (Konolong *et al.* 1992; Scales 1993; Scales *et al.* 1995; Knight *et al.* 1996). Similarly, tall fescue pastures have been shown to enhance animal performance, possibly as a result of a higher legume component than occurs with ryegrass (Merrick & Francis 1988), and may also reflect greater production of drymatter (Moloney 1991). The use of a high-endophyte ryegrass was expected to further impede animal performance on the control treatment. Fletcher *et al.* (1999) recorded suppressions in lamb summer/autumn liveweight gains ranging from 20 to 185 g/d owing to the presence of endophyte in ryegrass.

In the present experiment, chicory was included in the pasture mix for 58% of the Improved area and was the major component for 25% of Improved swards. Despite the inclusion of chicory, lamb performance was only higher for the Improved system during 1 of 3 years. The predicted increase in clover component associated with fescue swards only occurred during early summer in year 1 then declined markedly such that clovers represented <10% of the sward offered to

Table 9 Lamb meat production and income from two irrigated systems at Winchmore.

	Carcass weight kg[1]	Lamb Meat kg/ha[2]	Lamb income $/ha[3]
1997/98			
Control	16.8	408	1016
Improved	17.3	426	1065
LSD 0.05	0.7	14	43
Significance[4]	ns	*	*
1998/99			
Control	15.8	397	1020
Improved	15.9	383	993
LSD 0.05	0.8	31	60
Significance	ns	ns	ns
1999/00			
Control	15.9	411	964
Improved	16.4	371	927
LSD 0.05	0.9	97	100
Significance	ns	ns	ns

[1] from lambs reaching target weights.
[2] from lambs reaching target weights and stores.
[3] includes works returns from lambs reaching target weights and store values for the remainder.
[4] * = P<0.05; ns = non-significant

Table 10 Ewe liveweight (kg) from two irrigated pasture systems at Winchmore.

	21/3/97[1]	30/4/97	1/9/97	3/12/97	26/3/98[1]
1997/98					
Control	61	64	67	65	64
Improved	61	64	69	65	66
LSD 0.05	0.7	2.3	2.8	6.1	5.5
Significance[4]	ns	ns	ns	ns	ns
	30/3/98[1]	6/5/98	31/8/98	2/12/98	29/3/98[1]
1998/99					
Control	63	65	69	63	55
Improved	63	65	68	64	54
LSD 0.05	0.5	3.7	2.4	2.0	5.8
Significance[4]	ns	ns	ns	ns	ns
	29/3/99[1]	5/5/99	1/9/99	7/12/99	21/3/00[1]
1999/00					
Control	58	60	68	61	57
Improved	58	58	67	59	53
LSD 0.05	0.7	1.1	3.0	2.2	1.7
Significance[4]	ns	**	ns	*	**

[1] wool-free liveweights included to give a comparison at the start and end of years; [4] * = P<0.05; ** = P<0.01; ns = non-significant

Table 11 Ewe fleece weights (greasy kg) from two irrigated pasture systems at Winchmore.

	12/8/97[1]	27/3/98	23/3/99[2]	22/3/00[3]
Control	3.05	2.81	3.18	3.70
Improved	3.09	2.78	3.04	3.50
LSD 0.05	0.3	0.5	0.3	0.5
Significance	ns	ns	ns	ns

[1] previously shorn; November 1996, [2] March 1998, [3] March 1999.

lambs in year 3. A further disadvantage of the Improved system was the greater cost associated with additional requirements for conserved feed resulting in a feed deficit. In contrast the Control system remained self-sufficient.

The relatively poor performance of the lambs on the Improved system is contrary to the findings by previous workers (Fraser *et al.* 1999) who reported better lamb performance on the Improved compared to Control swards in summer dry systems at Winchmore. Fraser *et al.*'s (1999) Improved summer dry system had a greater proportion of its area in the higher quality swards, viz. chicory and hybrid ryegrass and chicory (75%) compared to the present study (58%), and fewer animals (12 vs 17/ha) which were drafted younger.

Had the same perennial ryegrass cultivar and management been used on this experiment as was used in the 35-year-old irrigated pasture described by Moss (1987a), the cost of the Control relative to the Improved treatment would have been further reduced. The 35-year-old swards were producing 13.5 t DM/ha annually and produced lamb growth rates similar to those on the present experiment (Moss 1987b) without pasture renewal.

Conclusion

Pasture growth rates were similar for perennial and hybrid ryegrasses, tall fescue and chicory based swards when compared under irrigation. However, pasture cover was on occasion, higher on the Control than Improved systems such that this system was self-sufficient in conserved feed while the Improved system had a deficit averaging 714 kg DM/ha/yr. The Control perennial ryegrass, and Improved system's tall fescue swards, contained similar proportions of grass and clover before lamb grazing. In comparison, hybrid ryegrass and chicory swards contained proportionally less grass and more chicory. Despite this apparent improvement in pasture quality, lambs on the Improved system grew faster then the Controls in year 1 only, when swards were young and contained more chicory. This resulted in more lambs being drafted on the Improved system (80 vs 95%), while in subsequent years, the proportion drafted was similar between treatments.

Although levels of pasture production were relatively consistent between years, there was considerable variation in lamb growth rates. This was most pronounced in the Improved system where pre-weaning rates averaged 266 and 216 g/d in years 1 and 3 respectively, and post-weaning rates 190 and 108 in years 1 and 2 respectively. The post-weaning variation appeared to coincide with fluctuations in clover and chicory content of swards, the proportion of which declined in autumn relative to summer and as pastures aged. The effect of age was most pronounced with chicory.

The Improved system gave financial returns from lamb production that were $49/ha higher than the Controls in year 1 but offered no advantage in subsequent years. Compared to the Control, the Improved system had the additional costs associated with more frequent pasture renewal and a conserved feed deficit.

Improvements anticipated to accrue from the inclusion of higher quality swards in an irrigated animal production system failed to achieve expectations, the reasons for which require further clarification.

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