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Attachment to Milestone Report

Project Code: MS.028

Project title: Best practice management to increase the profitability of Merino sheep meat production

Milestone Number: 5

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Introduction

The aim of this demonstration was to apply the key production drivers of Merino reproductive enterprises in an integrated fashion to explore the productive and financial potential of the best practice management approach. The key production drivers identified from mla project MS.020 were intensive rotational grazing and feed budgeting, prepartum protein supplementation and managing to achieve fat score targets (optimising soil fertility was used as a driver in all treatments).

The purpose of these approaches was to:

- optimise productivity and profitability per hectare while achieving animal targets
- enhance sustainability indicators such as ground cover, perenniality and water flow

The specific project objectives were:

1. Increase weaning rate per hectare by 20% to 11 lambs.

2. Increase kilograms of lamb weaned per hectare by 30% to 190 kg.

3. Reduce worm burdens in ewes leading to an annual reduction of 1 drench treatment.

4. Increase ground cover by 5-10% and reduce the presence of weeds by 10%.

5. Increase water infiltration rate by 10%.

6. Increase final gross margin per hectare by 60% (and assuming 2005 costs and returns) to $400/ha.

Materials and methods

<u>Demonstration design</u>

The demonstration compared three management types which are described in Table 1. The components that were common to all management types were Merino sires were selected on the basis of ASBV, soil chemical fertility was optimised and prelambing fat scores were managed to hit industry targets. In addition to these common elements, the first management type (CG low), employed continuous grazing at local stocking rates. The second management type (CG high) also employed continuous grazing but used the feed budgeting process to determine stocking rate. The third management type (IRG) differed by managing the fat score of ewes in the premating period by either preferential grazing or supplementation and used intensive rotational grazing. These management types can be viewed as exploring certain contrasts. For example, the difference between CG low and CG high is associated with feed budgeting while the difference between CG high and IRG is associated with premating fat score management and grazing management.

Table 1. Strategies employed by the three management types

	Management type		
	CG low	CG high	IRG
1. Appropriate genetics ASBV	👍	👍	👍
2. Optimise soil fertility	👍	👍	👍
3. Use feed budgeting to set stocking rates		👍	👍
4. Manage ewe FS at mating for targeted supplementation			👍
5. Manage ewe FS prelambing for targeted supplementation	👍	👍	👍
6. Continuous grazing	👍	👍	
7. Intensive rotational grazing			👍

<u>Animals</u>

One thousand and seventy nine mixed age (2.5-5 years of age) Merino ewes from the commercial Mt William flock were stratified on live weight and allocated at random into management type such that the starting numbers were 55 (CG low), 174 (CG high) and 850 (IRG). Ewe number variations over time are detailed in Table 2. If stocking rate required adjustment, the activities of ultra sound scanning for pregnancy status in August, and weaning in January provided the necessary opportunity. Within each management group, sentinel animals were tagged (RF tag and flock tag) and monitored as a representative subgroup. The typical number of sentinel animals was 30 (CG low), 40 (CG high) and 158 (IRG) which represented approximately 55%, 35% and 23% of the mean management group size.

<u>Grazing and pasture details</u>

There were two grazing regimes within the three management types, namely continuously grazed (CG) or intensive rotational grazing (IRG). The IRG regime utilised the Techno Grazing™ system, originally developed by Harry Weir of KiwiTech International, New Zealand. All ewes grazed on naturalized pasture. Soil samples (25 cores bulked in each management area; 0-10 cm) were collected and sent to a commercial laboratory for analysis. Soil tests indicated that the two areas had a similar topsoil chemistry (Table 3) at the start of mla MS.020 and continue to be similar. Fertiliser applications over the 5-year period to optimise soil fertility have provided 82 kg P/ha and 80 kg S/ha for CG and 109 kg P/ha and 93 kg S/ha for IRG.

Table 2: Time course indicating the change in the number[A] of animals

2006	CG low	CG high	IRG	2007	CG low	CG high	IRG	2008	CG low	CG high	IRG
Jan	-	-	-	Jan	53	110	754	Jan	50	103	618
Feb	-	-	-	Feb	53	110	754	Feb	60	140	745
Mar	55	174	850	Mar	53	65	550	Mar			
Apr	55	174	850	Apr	57	65	540	Apr			
May	55	174	850	May	57	65	540	May			
Jun	55	174	850	Jun	57	67	540	Jun			
Jul	55	153	837	Jul	57	67	540	Jul			
Aug	55	153	837	Aug	51	75	507	Aug			
Sep	53	138	852	Sept	51	75	507				
Oct	53	138	852	Oct	51	75	507				
Nov	53	138	852	Nov	51	75	507				
Dec	53	138	831	Dec	55	75	507				

[A] Note that final numbers for statistical analysis of various traits may differ from that in this table.

Table 3: Topsoil (0-10cm) chemistry of demonstration areas on Mt William over the period 2003 – 2008.

	CG					IRG				
	‘03	‘04	‘06	‘07	‘08	‘03	‘04	‘06	‘07	‘08
Olsen phosphorus (ppm)	6.0	15.3	18.2	14.4	15.0	8.0	12.0	12.0	21.6	16.1
Sulphur KCl40 (ppm)	2.5	9.3	10.2	12.2	11.2	4.6	9.6	10.2	14.1	10.1
Potassium Colwell (ppm)	150	140	133	114	174	98	120	103	116	97
pH (CaCl)	4.9	4.7	4.6	4.6	4.9	4.8	4.8	4.8	4.6	4.8
Organic carbon (%)	2.0	2.5	2.6	3.1	2.2	1.7	2.1	2.0	1.8	1.6
Cation exchange capacity (meq/100g)	4.5	5.8	5.2	5.1	5.3	2.8	5.0	4.5	4.3	3.3
Aluminium (% of CEC)	4.5	2.7	3.3	1.5	2.5	6.3	0.7	0.9	1.3	2.2

CG low occupied a paddock of 10 ha and CG high a paddock of 14 ha. Approximately 200m from the CG area, an area of 74.4ha was surveyed, fenced and watered to establish a Technograze system for IRG in 2003. In brief, the system is comprised of 6 lanes each of area 12.4 ha. The lanes run parallel to each other and are on average 80m wide x 1550m long. A 3 wire electric fence separates lanes. Within lanes, paddocks (notionally referred to as cells) are designated by use of a movable temporary 2-wire electric fence. There is a maximum of 30 cells/lane (ie. cell area = 0.42ha). Water is provided as 3 main lines along the boundary of lanes 1&2, 3&4 and 5&6. Each watering point (1 per cell) is comprised of a reticulated trough (approx. 70 L volume) located directly below the interlane fence allowing access from both lanes.

Typically 2 equal sized groups graze in the IRG. The number of cells and the number of days allowed in each grazing event varied throughout the year in response to feed allocation and pasture growth. On average stock density was approximately 190-380 ewes/ha with a graze period of 2-4 days and a recovery period of 40-80 days.

Supplement

Prepartum supplementation was provided as cottonseed meal pellets (CSM; 445g crude protein/kg DM; ca. 45% rumen undegradable dietary protein) at the rate of 150 g/day. Ewes received supplementation (dispensed onto the ground) three times per week for the 6-7 weeks prior to the start of lambing.

Worm control

Worm burdens were monitored through faecal worm egg counts (WEC) and decisions on treatment were made independently for each management group and with reference to the Integrated Parasite Management in sheep drench decision aid. The drench history for the groups is provided in Table 4.

Table 4: Anthelmintic treatments for ewes

Date	CG low	CG high	IRG
8 March 2006	Rametin + albendazole	Rametin + albendazole	Rametin + albendazole
23 June 2006	Albendazole + levamisole		
14 July 2006		Albendazole + levamisole	Albendazole + levamisole
26 Sept 2006	Rametin + albendazole	Rametin + albendazole	Rametin + albendazole
12 November 2006	Cydectin injection	Cydectin injection	Cydectin injection
21 January 2007	Rametin + levamisole	Rametin + levamisole	Rametin + levamisole
28 February 2007	Cydectin LA	Cydectin LA	Cydectin LA
27 Sept 2007	Rametin + albendazole	Rametin + albendazole	Rametin + albendazole
16 Jan 2008	Rametin + levamisole	Rametin + levamisole	Rametin + levamisole

Levamisole (8mg levamisole hydrochloride per kg weight); Rametin (32mg napthalophos, per kg weight); albendazole (5mg albendazole oxide per kg weight), cydectin injection (0.2mg moxidectin per kg weight); cydectin LA (1mg moxidectin per kg weight).

Pasture sampling

Pasture was periodically sampled from each grazing area using a median quadrat containing five subquadrats (subquadrat area of $0.15m^2$). For each CG area, a total of 5 sampling locations were chosen using a stratified approach where areas of low, medium and high herbage mass were proportionally sampled. For the IRG area, a total of 6 sampling locations were chosen, with three locations in the current area of grazing and three locations from the area next to be grazed. Pasture was dried at 70°C for 5 days to determine dry matter content.

Live weight, parasitology and wool

Ewes were moved to yards for determination of live weight and fat score as detailed in Table 5. Lambs were weighed at lamb marking and weaning. Faeces were collected from the rectum of ewes and lambs (Table 5) and WEC conducted using a modified McMaster method (lower level of detection 60 epg). From each sampling, approximately equal quantities of faeces from within management group were combined and cultured at 27°C for 7 days to allow microscopic identification of nematode genus. Greasy fleece weights (preskirting) and including bellies, were determined at shearing and a sample from the midside was collected for analysis of wool quality by a commercial laboratory.

Table 5: Timing of live weight, fat score, individual worm egg count and wool measures.

Date	Live weight		Fat score		Worm egg count		Wool	
	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs
20 Apr 2006	X		X		X			
3 Aug 2006	X		X		X			
23 Aug 2006							X	
26 Sept 2006	X		X		X			
22 Nov 2006	X	X	X					
21 Jan 2007	X	X	X		X	X		
4 May 2007	X		X					
31 July 2007	X		X		X			
31 Aug 2007							X	
28 Sept 2007	X		X		X			
21 Nov 2007	X	X	X		X			
16 Jan 2008	X	X	X		X	X		

Statistical analysis

Most data were analysed using a general linear model (JMP5.1, SAS Institute). Reproductive data were analysed with nominal logistic regression (JMP5.1, SAS Institute). The reproductive traits were defined as pregnancy (pregnant ewe / 100 ewes mated), survival (lambs at marking / 100 pregnant ewes), lamb marking (lambs / 100 ewes mated) and weaning (lambs / 100 ewes mated). The effects in the model were management type, ewe age, pregnancy status, lactation status and prepartum supplementation. However, only the effect of management type will be presented in this report because it is central to the project objectives, whereas the other sources are fixed effects. WEC were cube-root transformed prior to analysis and back transformed means (± 68% confidence intervals; c.i.) are presented. Least square means ± standard error (se) are presented for all other variables.

Results

Live weight

Initial live weight did not differ among management groups in either the first or second year of the demonstration but was a significant (P<0.001) covariate for subsequent measures. Live weight of IRG ewes was greatest (P<0.001) during the prepartum period of 2006 and did not differ among CG groups (Figure 1). By lamb marking, both IRG and CG high ewes lost weight such that CG low and IRG ewes were heavier than CG high. Growth between marking and weaning (2 months) resulted in IRG ewes being the heaviest, CG low intermediate and CG high the lightest (P<0.001). In 2007, CG high ewes were heavier (P<0.001) than either CG low or IRG ewes up to lamb marking. Subsequent growth by IRG ewes and weight loss by CG high ewes, resulted in equivalent weights which were greater than for CG low.

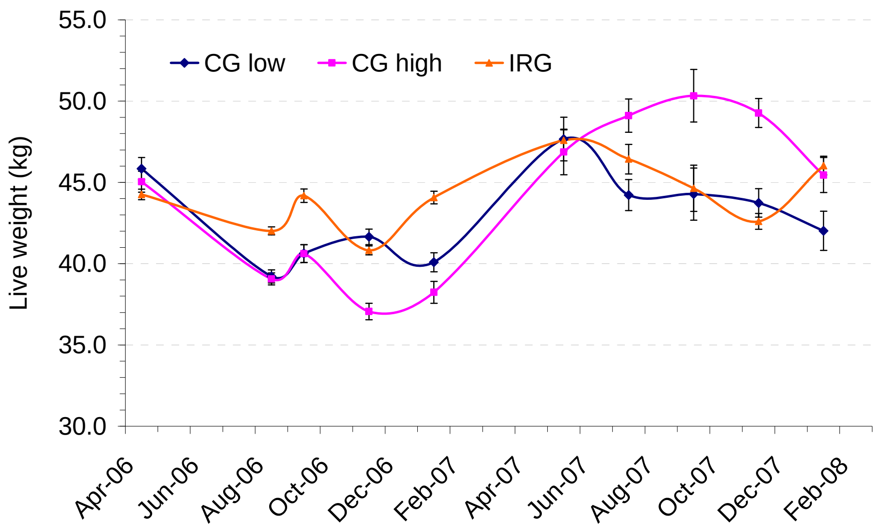

Figure 1: Live weight (lsmean ± se) of ewes that were managed in CG low, CG high or IRG groups over the two years of the demonstration.

Fat score

Initial fat score (FS) did not differ among management groups in either the first or second year of the demonstration but was a significant (P<0.001) covariate for subsequent measures. Fat score differences mirrored live weight changes (Figure 2). Ewes from all groups achieved the mating FS target of 3.0 – 3.3 (3 to 3 plus) in 2006 and in 2007. In contrast, lambing FS targets (for a predominantly single-bearing flock) of 3.0 were not achieved by CG low ewes in either 2006 or 2007. CG high ewes had the lowest FS in 2006 (FS=2.3) and the greatest in 2007 (FS=3.7) and in association were 10 kg heavier at lambing in 2007. IRG ewes closely approximated FS targets in 2006 (FS=2.8) and achieved the target in 2007.

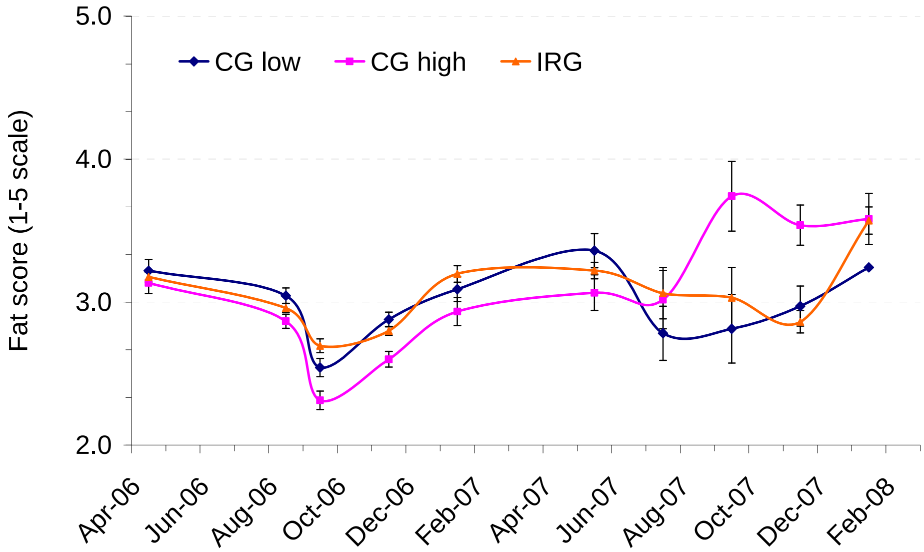

Figure 2: Fat score (lsmean ± se) of ewes that were managed in CG low, CG high or IRG groups over the two years of the demonstration.

<u>Wool</u>

Greasy fleece weight of CG low ewes was greater ($P<0.05$) than IRG ewes in 2006 but no differences were evident in 2007 (Table 6). Mean fibre diameter and washing yield did not differ significantly among management groups. Staple length of CG low ewes was greatest ($P<0.001$) in 2006 but did not differ in 2007. Staple strength of CG high ewes was greater ($P<0.05$) than IRG ewes in 2006 but in 2007, the staple strength of CG low ewes was greatest ($P<0.01$).

Table 6: Least squares means (± se in brackets below lsmean) of greasy fleece weight (GFW), mean fibre diameter (FD), Washing yield (Yield), staple length (SL) and staple strength (SS) of ewes at shearing in 2006 and 2007.

	2006			2007		
	CG low	CG high	IRG	CG low	CG high	IRG
GFW (kg)	3.2^{a}	3.0^{ab}	3.0^{b}	3.1	3.3	3.1
	(0.1)	(0.07)	(0.04)			
FD (µm)	17.7	17.8	17.4	18.2	18.3	17.8
Yield (%)	85.6	84.2	84.0	86.9	85.6	85.1
SL (mm)	85.4^{a}	78.4^{b}	76.7^{b}	85.3	84.5	84.1
	(1.84)	(1.48)	(0.76)			
SS (k/Ntex)	49.9^{ab}	51.9^{a}	46.7^{b}	54.3^{a}	44.1^{b}	46.1^{b}
	(2.47)	(2.00)	(1.02)	(2.76)	(2.63)	(1.05)

Note: Means within wool trait and year with superscripts that differ are significantly different ($P<0.05$; GFW), ($P<0.001$; SL), ($P<0.05$; SS 2006) and ($P<0.01$; SS 2007).

Worm egg count

WEC did not differ between management groups at the start of the 2006 and 2007 demonstration year. Consistent differences in WEC were not evident among the groups but weaning (the time of high challenge and low host resistance) indicated that IRG ewes were typically lower than one of the CG groups (Figure 3): CG high in 2006 (P<0.05) and CG low in 2007 (P<0.10).

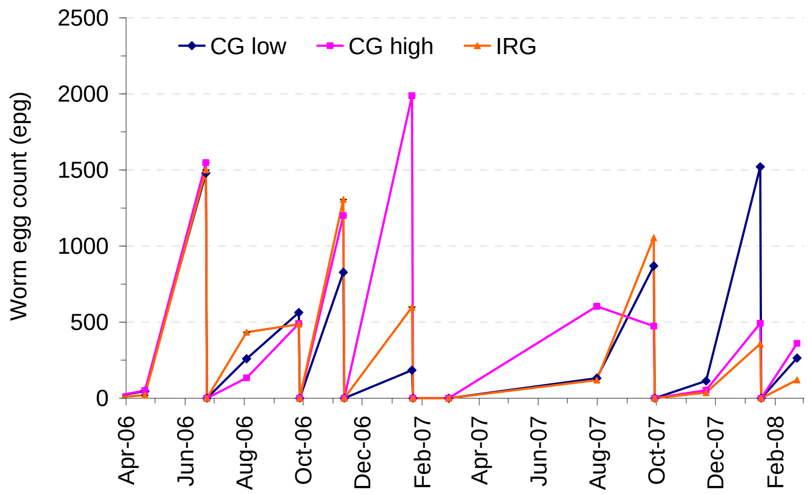

Figure 3: Worm egg count (back transformed lsmean) of ewes that were managed in CG low, CG high or IRG groups over the two years of the demonstration. WEC was set to zero after an effective drench was administered.

Reproduction and survival

Rates of pregnancy, survival, lamb marking and weaning did not differ among CG management groups in either 2006 or 2007 (Figure 4). Pregnancy rates of IRG ewes did not differ from CG management groups in either year. Survival of IRG lambs was greater (P<0.01) than for CG group in both years. Lamb marking rates were greater in IRG ewes in both years (P=0.08 in 2006; P<0.001 in 2007) as were weaning rates (P<0.05 in 2006 and P<0.001 in 2007). There were significant differences between years in reproduction and survival. For example, pregnancy rates in 2007 (93.2%) were greater (P<0.001) than in 2006 (85.3%) but lamb survival did not differ. Lamb marking (81.0%) and weaning (80.0%) rates in 2007 were both greater (P<0.001) than in 2006 (71.1% and 71.1% respectively).

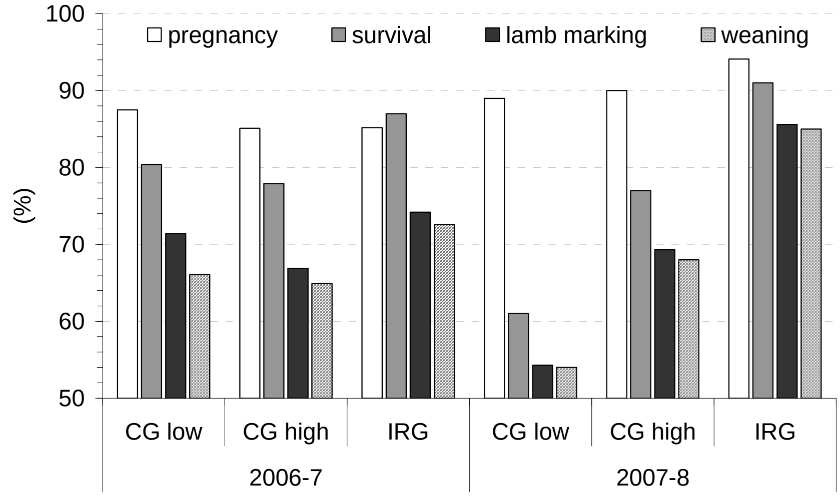

Figure 4: Rates of pregnancy (% of ewes mated), lamb survival (% of pregnant ewes), lamb marking (% of ewes mated) and weaning (% of ewes mated) of ewes and their lambs that were managed in CG low, CG high or IRG groups over the two years of the demonstration.

Lamb weight

Lamb weight at marking in 2006 was greatest in the CG low management group, intermediate for CG high and lowest for IRG (P<0.001; Figure 5). CG low lambs were still heavier (P<0.001) at weaning but no differences existed between CG high and IRG lambs. Growth between marking and weaning was 120 g/day for CG low and IRG lambs but only 100 g/day for CG high; accounting for the similar weaning weights of CG high and IRG lambs.

Lamb weight at marking (P<0.001) and weaning (P<0.01) in 2007 was greatest in the CG high management group and not different between CG low and IRG (Figure 5). Growth between marking and weaning was 112 g/day for CG low, 119 g/day for CG high and 131 g/day for IRG lambs.

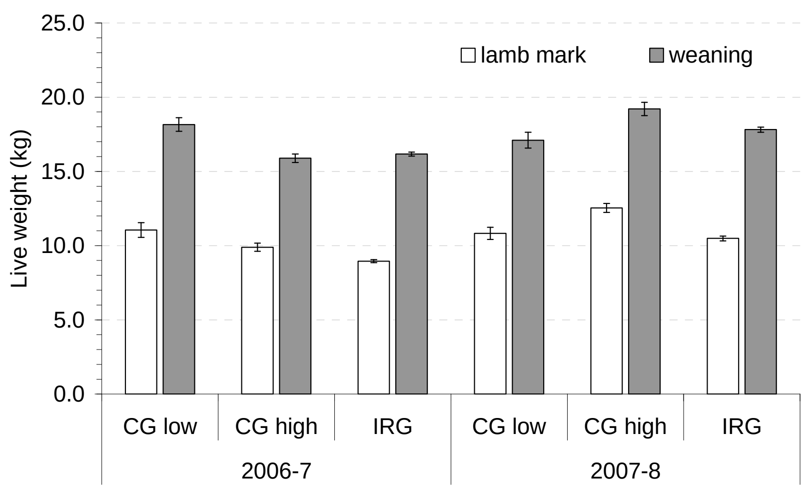

Figure 5: Live weight (lsmean ± se) of lambs at lamb marking and weaning reared by ewes that were managed in CG low, CG high or IRG groups over the two years of the demonstration.

Pastures

Herbage mass at the start of the demonstration was affected by the treatments imposed in the previous mla MS.020 project and were greater in CG high. At the estimate prior (19 Dec 2005) to the start of this demonstration, herbage mass values were 960 CG low, 2239 CG high and 1588 IRG. Differences among management groups appeared to diminish over the following 10 months and from November 2006 were similar, with the exception of greater herbage mass in the CG high paddock in February 2008.

The components of basal cover are provided in Table 7. Averaged over the 2-years of estimates, basal cover of dung in CG high was greater than in IRG; litter cover was greatest in IRG; and bare ground was greatest in CG low. Native and naturalised perennial grasses made the greatest (P<0.05) contribution to herbage mass in the CG management paddocks, though this was almost completely due to a greater (P<0.05) contribution of the unpalatable and short-lived perennial native grass, *Eragrostis red* (Table 8). There was a suggestion (P<0.10) that IRG management was associated with a greater contribution of annual grasses and broad-leaved plants (principally *Hypochoeris radicata*).

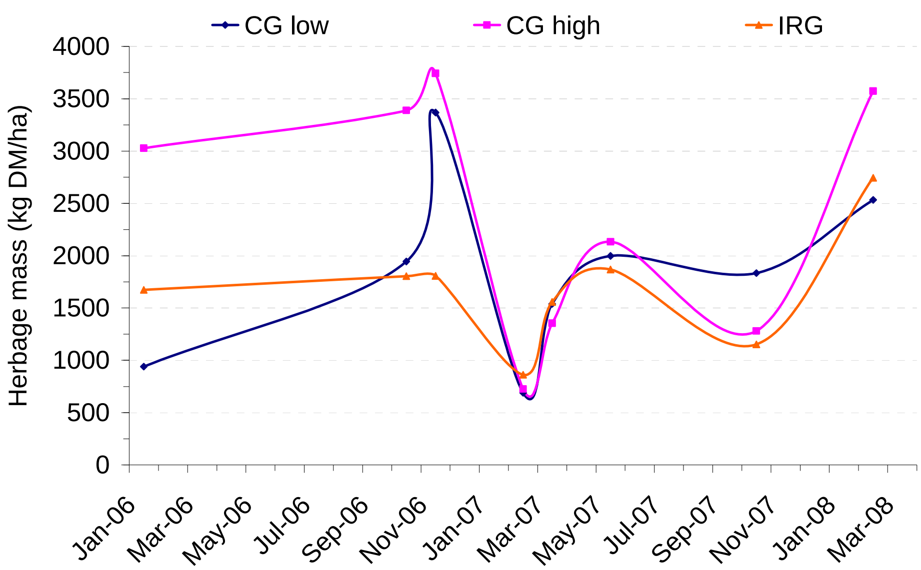

Figure 6: Herbage mass of paddocks that were managed as CG low, CG high or IRG over the two years of the demonstration.

Table 7: Components of basal cover in the CG low, CG high and IRG management paddocks over the period 2006-2007.

	CG low	CG high	IRG	P value
Dung	3.5[ab]	5.0[a]	1.3[b]	0.02
Litter	58.5[ab]	53.3[b]	67.5[a]	0.03
Bare	12.7[a]	5.5[b]	4.9[b]	0.05
Native & naturalised perennial grass	17.8	25.9	18.7	NS
Annual grass	1.0	3.0	2.7	NS
Broadleaved	4.9	2.7	3.3	NS
Legume	0.0	2.1	0.3	NS
Eragrostis red	3.2	3.6	1.3	NS

Table 8: Contribution (%) to herbage mass in the CG low, CG high and IRG management paddocks over the period 2006-2007.

	CG low	CG high	IRG	P value
Native & natural perennial grass	88.0[a]	88.1[a]	55.1[b]	0.04
Annual grass	1.5	14.9	29.4	0.08
Broadleaved	0.0	5.5	14.7	0.08
Legume	0.6	0.0	0.0	NS
Eragrostis red	30.0[a]	28.5[a]	0.3[b]	0.02
Native & naturalised grass less *Eragrostis red*	58.0	59.6	54.8	NS

The area of each management group covered with black (*Cersium vulgare*) and slender (*Carduus tenuiflorus*) thistle was greatest in the CG paddocks and this was aligned with a greater density of thistles within these areas (Figure 7).

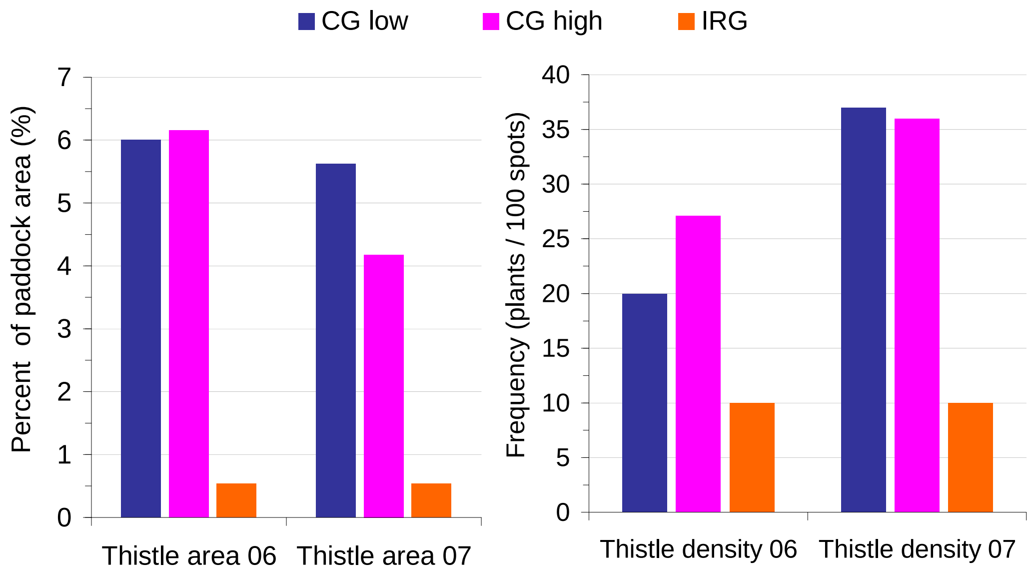

Figure 7: Area covered by thistles (*Cersium vulgare* and *Carduus tenuiflorus*) and the density of thistles within these areas in paddocks that were managed as CG low, CG high or IRG over the two years (2006-2007) of the demonstration.

<u>Water</u>

Infiltration rate at low tension (ie. soil macropores) was greatest in CG low and IRG paddocks and least (P<0.001) in CG high.

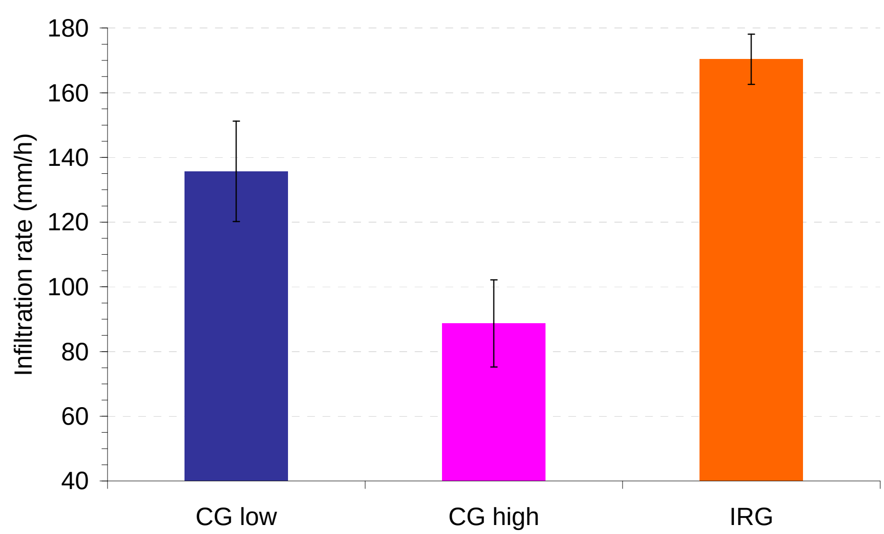

Figure 8: Infiltration rate (macropore -10mm tension; lsmean ± se) of paddocks that were managed as CG low, CG high or IRG during 2006 of the demonstration.

Financial
Gross margin analyses were conducted for the production cycles of 2006-07 (March 2006 – Feb 2007) and 2007-08. Proceeds from the sale of wool were calculated from the input of greasy fleece weight and wool quality data into "woolcheque" (AWI software). Sale price of cull and remaining ewes was determined by Mr Angus Carter, Landmark, Walcha who valued the animals without knowledge of management groups. Sale price of weaners was determined from live weight and a price of $1.50 / kg live weight. Variable costs were determined from actual expenditure and labour input for each management group was estimated by the manager of Mt William. Interest (5% p.a.) was charged against the capital cost of animals and the depreciated capital cost of infrastructure (such as water and fence) as these represent different management group capitalisation.

Gross margin per hectare was greatest and less variable over the 2-year period with IRG management (Table 9).

Table 9: Gross margins ($/ha) for the annual periods March 2006 – February 2007 and March 2007 – February 2008 for CG low, CG high and IRG management paddocks.

	CG low	CG high	IRG
2006-07	$86.87	$277.62	$320.94
2007-08	-$28.52	$28.17	$170.61
Mean	$29.18	$152.90	$245.78

Publicity
Two field days have been held at Mt William with 45 attendees at each event (ie. total of 90). Two articles have been submitted and published in mla prograzier.

Discussion
The 3 management groups allowed a contrast of the relative importance of feed budgeting and grazing management for optimising productivity and profitability per hectare and enhancing sustainability indicators such as ground cover, perenniality and water flow.

The mean stocking rate of the 3 management groups was 5.1, 8.0 and 9.3 ewes/ha for CG low, CG high and IRG respectively. The variability of stocking rate differed among the groups with the ratio of maximum to minimum ewe numbers per hectare being 1.2, 2.7 and 1.7 for CG low, CG high and IRG respectively. Low variability in CG low was anticipated as the management approach did not use feed budgeting to set stocking rates. Those management groups that used feed budgeting (CG high and IRG) had a greater variation in stocking rate but this was greatly exaggerated with continuous grazing. There was little difference in ewe live weight or fat score between CG low and IRG, even though stocking rates averaged 4.2 ewes/ha (82%) greater. In contrast, ewe live weight and fat score of CG high animals was in turn less than, and greater than, the other groups. CG high ewes experienced a 13 kg difference between maximum and minimum live weights, whereas this value was 9 kg and 6 kg for CG low and IRG respectively. Taken together, these data indicate that intensive rotational grazing allowed the attainment of greater stocking rates without concomitant effects on per head live weight.

Greasy fleece weights and yield were greater in 2006 for CG low ewes. Differences also existed, in both years, for staple strength, but all groups were well above industry standards. The wool data also captured the greater variation in animal performance in CG high, with greater variation in fleece weights and staple strength. What was difficult to capture was the effect of horehound seeds in the fleeces of CG low ewes as these were skirted from the fleece and not represented in the sample sent for analysis. Regardless of the sporadic differences in individual wool production, annual wool production per hectare averaged, 16.1 kg, 25.2 kg and 28.4 kg for CG low, CG high and IRG ewes respectively.

The effect of grazing management on worm burdens was not anticipated to be large as periods of recovery were timed to optimise pasture growth rather than maximise the death rate of infective larvae on pasture. Nevertheless, there was a strong suggestion that worm burdens of IRG ewes were generally lower than CG ewes at weaning. This trend was supported by the large differences in worm egg counts of lambs at weaning (Figure 9). This transient but large effect on worm egg count at weaning has also been reported as part of mla MS.020 and has been apparent in 4 of the 5 years under observation.

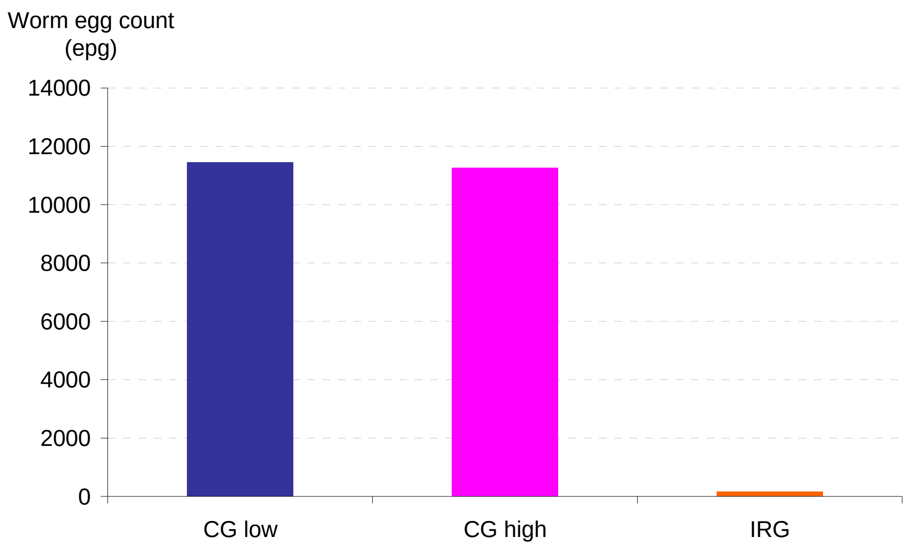

Figure 9: Worm egg counts of lambs at weaning in January 2008.

Pregnancy rates increased by 8% points in 2007 in association with the oral administration of 5 mg selenium 1 month prior to mating. There were no differences among management groups in pregnancy rates which, given similar fat scores at mating, were not expected. Interestingly, survival of lambs to lamb marking (approx. 7 weeks after the start of lambing) was greatest in the IRG group and this confirms that reported in mla MS.020. Greater survival led onto greater rates of weaning in both years and the increase in IRG from 74% in 2006 to 84% in 2007 was a function of greater rates of pregnancy and greater survival. The mechanisms of the greater survival have not been the subject of close examination but may be associated with, small lambing ewe mobs (typically < 80 ewes), small paddocks and the use of electric fences limiting fox predation.

Lamb weights at marking have typically been greater with CG management, though some compensation in IRG till weaning has been apparent. Differences in individual lamb weights have been in contrast to effects on weight of lamb weaned per hectare which has averaged 53 kg, 81 kg and 120 kg for CG low, CG high and IRG respectively.

IRG paddocks have been characterised by having a greater basal cover of litter, less bare ground and less dung (despite greater stocking rates), with a greater contribution from annual grasses and broadleaved plants and a smaller area occupied with thistles. The net effect of these changes has been that herbage mass of CG low and IRG paddocks has been similar over the 2-year period, suggesting that pasture growth rate and water use efficiency may have been greater (this will be detailed in the next report) to have supported a greater stocking rate. In contrast, herbage mass of the CG high paddock has fluctuated over a wider margin. Water infiltration has not been associated with stocking rate as greater rates were recorded in IRG and CG low and lesser rates in CG high. This measure will be repeated later this year.

Mean gross margins were increased by $123.72/ha by the use of feed budgeting to increase stocking rate. Adoption of intensive rotational grazing increased gross margins a further $102.88. Reflecting the variation at the individual animal level and stocking rate, the variation in gross margin has been smallest in IRG than either of the CG management groups.

Conclusion

In summary, feed budgeting and planning led to higher stocking rates, greater animal production on a per hectare basis and increased gross margin. However, increasing stocking rates with a continuous grazing management resulted in a greater variation in stocking rate, staple strength, weaning rate and gross margin. This variation represents greater risk to sheep producers and to the environment. IRG had the additional benefits of fewer worms and less stock losses (neonatal and to haemonchosis), less bare ground, more litter, fewer thistles and greater rate of water infiltration. These data indicate that IRG is a more reliable management type allowing higher stocking rates while minimising risk exposure and improving the state of natural resources.

Comparison against project objectives

Comparison against the specific project objectives has highlighted:

1. Increase weaning rate per hectare by 20% to 11 lambs.

Two-year mean weaning rate from IRG ewes has been 78.8% compared to 63.2% for CG groups. The number of lambs weaned per hectare has been 7.8 and 4.4 respectively. This represents a 77% increase in the number of lambs weaned per hectare but is below the target.

2. Increase kilograms of lamb weaned per hectare by 30% to 190 kg.

Two-year mean weight of lamb weaned per hectare has been 53 kg CG low, 81 kg CG high and 120 kg IRG. This represents a 48% increase in the number of lambs weaned per hectare from IRG relative to CG high but is below the target.

3. Reduce worm burdens in ewes leading to an annual reduction of 1 drench treatment.

IRG has not resulted in fewer treatments but WEC at weaning of ewes and lambs has been reduced compared to CG groups. This has reduced worm-related deaths and contributed to greater gross margins.

4. Increase ground cover by 5-10% and reduce the presence of weeds by 10%.

Basal cover estimates of bare ground have averaged 12.7% CG low, 5.5% CG high and 4.9% IRG. Thistles have occupied 5.4% CG groups and 0.5% IRG of the paddock with thistle density of 28 and10 plants per 100 locations respectively. IRG has achieved the target.

5. Increase water infiltration rate by 10%.

Infiltration has only been measured on the one occasion and was 170 mm/h IRG, 136 mm/h CG low and 89 mm/h CG high. IRG has achieved the target.

6. Increase final gross margin per hectare by 60% (and assuming 2005 costs and returns) to $400/ha.

Gross margin has averaged $246 IRG, $29 CG low and $153 CG high. This represents a 61% increase of IRG relative to CG high, but falls short of the $400/ha target.

IRG management has been recorded to produce the percentage increase in project objectives but fall short of the quantitative objectives suggesting that land capability may be limiting.