An evaluation of a possible complementary effect of grazing goats with bulls in an intensive bull beef system

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ABSTRACT

A field trial at Flock House over a three year period (July 1989 - March 1992) compared the performance of grazing bulls alone at three stocking rates (3.0, 3.7 and 4.5 bulls/ha) with grazing bulls at 3.0 bulls/ha with an increasing stocking rate of goats (3, 7, and 13 Angora does/ha). The respective stocking rates in stock units (su/ha) for the six respective treatments from bulls alone at increasing stocking rate to bulls with goats at increasing stocking rate of goats were 15, 19, 23, 18, 21, and 26 su/ha respectively. Weaner bulls were brought onto the farmlets in November each year and all rising 2 year bulls were sold off the farmlets over January to April at 18-21 months of age.

Bull growth rates were significantly depressed by increasing the stocking rate of bulls but were unaffected by an increasing stocking rate of does. Bulls in the bull/goat treatment at 26 su/ha grew at a similar rate to bulls alone, stocked at 15 su/ha. Goat performance; kidding, kid fleece weight and doe fleece weight were not affected by goat stocking rate. However at the high doe stocking rate, kid liveweight at weaning and doe liveweight (March) was reduced ($P<0.01$ and $P<0.05$ respectively). Stocking rate treatments had little effect on the economic farm surplus (variation between $680/ha for the least profitable to $730/ha for the most profitable treatments). However with a more buoyant mohair market and a more robust/productive strain of Angora goat ie. the Zimbabwe Angora, it is assumed the bull/goat system would be more profitable than bulls alone.

Although goats were not complementary to bull beef production they were also not competitive with bulls over the stocking rates investigated.

Keywords: mixed species grazing, bulls, goats.

INTRODUCTION

The beneficial effects of grazing goats with other animal species on the control of weeds especially gorse and thistles and possible increased cattle performance has been well documented by farmers (Leighton 1978, Garland 1981, McLaughlin 1992) and researchers (Rolston *et al.*, 1982, Clark *et al.*, 1984, Radcliffe 1985). The observations and measurements made in these reports clearly show that the grazing behaviour of goats differed markedly from sheep and cattle. Pastures grazed predominately by goats were longer and were dominant in white clover in comparison with sheep grazed pasture. Work by Collins & Nicol (1986) clearly showed that goats would perform better on pastures of higher herbage mass than cattle and goat intake was more markedly affected by declining herbage mass levels than the intake of cattle.

From this information the assumption could be drawn that at relatively low cattle stocking rates, goats would not be competitive with cattle as they would preferentially graze the longer pasture rejected by cattle. This possibly would improve pasture quality and make the pasture overall more acceptable to cattle.

To improve the profitability of beef production on intensive bull beef units lower stocking rates than adopted in practice were recommended (McRae & Morris 1984). To demonstrate this principle, demonstration units at Flock House and at Massey University's Tuapaka Beef Unit were established. Bull growth rates on the Flock House unit were well below the desired target suggested by McRae & Morris (1984) despite adequate pasture available and on the Tuapaku unit intensive pasture conservation was practised to maintain pasture quality to ensure targeted bull growth rates.

To improve pasture quality and maintain high growth rates of bulls and high profitability the concept of integrating goats into a relatively low-stocked bull beef system was investigated.

METHOD

The overall objective of the trial was to determine if the addition of goats to a low stocked bull beef system (3 bulls/ha) would improve bull growth. To determine a possible complementary effect of goats on bull beef production the concepts of Connelly and Nolan (1976) and Nolan and Connelly (1977) on determining complementarity in mixed grazing systems were adopted in designing the trial. The concept of using mixed grazing systems with similar stock equivalence was rejected to avoid confounding stocking rate effects. Also no attempt was made in designing the trial to determine the effect of cattle on the performance of goats, as goat performance was considered secondary to the primary objective of improving bull beef production.

The trial design is described in Table 1. The trial commenced on the area in August 1989 and concluded in March 1992 following the sale of all rising 2 year old bulls. The trial

TABLE 1: The Trial Layout

Treatment	Area (Ha)	No Animals Bulls	Does	No Paddock	Stock Rate Bulls/ha	Does/ha	Stock Units/ha
Bulls Alone							
Bulls-Low stocked (BLS)	3	9	-	4	3	-	15
Bulls-Medium stocked (BMS)	2.4	9	-	4	3.7	-	19
Bulls-High stocked (BHS)	2	9	-	4	4.5	-	23
Bulls + Goats							
Bulls + Goats Low stocked (GLS)	3	9	10	4	3	3	18
Bulls + Goats Med. stocked (GMS)	3	9	20	4	3	7	21
Bulls + Goats High stocked (GHS)	3	9	40	4	3	13	26
Stock units (MAF 1992)							
1 bull = 5su							
1 doe = 0.8su							

area was blocked into 4 areas of similar pastures and paddocks for the six grazing treatments were randomised within each block. Twelve month old bulls and mixed age pregnant does were used at the start of the trial in August 1989. Increasing stocking rate on the bull alone treatments was achieved by maintaining 9 bulls on all treatments and reducing farmlet area to achieve the appropriate stocking rate. For the bull + goat treatments increasing goat stocking rates were achieved by increasing the number of does/treatment. Four paddocks/treatment was considered minimal for the running of grazing trials and in a previous trial run by Thomson and Power (1991) such a design was effective at maintain low operating costs while achieving effective and practical comparative data. All bulls were purebred Friesian and the does purebred New Zealand Angora. In November each year 9 weaner bulls calves/treatment were bought onto the trial and rising 2 year bulls were sold off the trial from mid-January to early April. Sale of bulls was dictated by feed budgeting and the requirement to achieve positive liveweight gain from bulls at all times. The management objective was to finish all bulls (liveweight 475kg) but if the feed budget showed that positive liveweight gain could not be maintained the lighter bulls (usually around 400-420kg liveweight) were sold first off the trial area as "stores".

Bulls that were physically damaged or had definable health problems were replaced with a bull from a reserve mob with a liveweight that did not affect the group mean or liveweight variance within the group.

Does kidded in September/October and were shorn in February and August each year. Kids were shorn, weaned and removed from the trial area in February. In April each year 20-30% of does were replaced with doe hoggets and throughout the year does that died were replaced to maintain the goat stocking rate. No attempt was made to maintain an equal ratio of kids and does across treatments over the September -February period.

Grazing Management

From August to April a grazing rotation for bulls of around 25 days was maintained and through winter this was increased to 80-100 days. In spring a target residual herbage mass of 2000kg DM/ha was set and when this was exceeded an area of pasture considered surplus was taken out of grazing and conserved as either silage or hay. Feed conserved was fed back to the respective treatments during feed deficit periods.

A set policy for the management of bulls and goats was established at the commencement of the trial and maintained throughout. That was: over kidding (mid-September - mid October) does were set stocked and the bulls rotationally grazed; Mid-Oct - Mid-January does and kids followed the bulls and when the weaner bulls came on in November the order of grazing was; weaner bulls, older bulls then does and kids. Following kid weaning the rising 2 year bulls and does were in one mob following the calves. From mid May to early August the does were grazed ahead of the bulls to ensure they achieved an adequate intake to maintain liveweight.

Trial Management

Calves were randomly allocated to treatments on a liveweight basis and liveweights were recorded monthly for all bulls at 9-10am on the last day of grazing a paddock. From mid-January to April all bulls were weighed fortnightly to update feed budgets and organise sales. Does were initially allocated to treatments on an age and liveweight basis and doe hoggets were allocated randomly to treatments each year on liveweight only. Does were weighed monthly except through kidding and kids were weighed at birth and at weaning. At each shearing, does and kids individual fleece weights were recorded and a classification for each fleece given.

On a monthly basis faecal samples were collected from 10 does in each treatment and an anthelmintic drench given to the respective treatment if the average faecal egg count exceeded 800 eggs/gram. In the last 18 months of the trial blood samples were collected on a monthly basis from 3 bulls/treatment and all bulls in individual treatments were given an anthelmintic drench if the average blood pepsinogen levels exceeded 1.5 I.U/100ml.

Herbage mass levels of each paddock were assessed weekly using the Pasture Probe and to convert meter reading to herbage mass the equations, published by L'Hullier and Thomson (1987) were used. From the herbage mass measurements pasture accumulation rates were calculated using the difference method. Intensive studies on botanical composition, tiller densities and Californian thistle populations were also conducted but the results will not be presented in this paper.

The price at sale of all produce; bull beef, mohair (kids and does), goat kids and cull does was recorded. From standardised farm costs (MAF 1992) gross margins/treatment/year were calculated.

All data recorded on liveweight and fleece weights were statistically analysed by using the SAS statistical package. For this paper all liveweight and fleece weight data presented showed no treatment by year interaction which enabled averages recorded over the trial period to be presented. The average liveweight gain of bulls over the trial was calculated from liveweight gain of bulls recorded from November 1989 - January 1991 and November 1990 - January 1992. Over these periods all bulls were on respective treatments and liveweight gains were not confounded by variable sale dates.

RESULTS

The average liveweight gain of bulls (Table 2) was depressed (P<0.01) with increasing stocking rate of bulls alone. Liveweight gains on the GMS and GHS treatments were similar to the BLS treatment and greater (P<0.01) than the BMS and BHS treatments. Liveweight gain for the lower stocked goat treatment (GLS) was less (P<0.05) than either the GMS or GHS treatments but greater (P<0.01) than the BMS and BHS treatments.

TABLE 2: Bull performance; average liveweight gain/day (weaning to R2 year old) over 2 years, average liveweight at sale and % of store bulls at time of sale over the 3 years of the trial.

Treatment	Liveweight gain (kg/bull/day)	Sale Liveweight (kg)	% Store
Bulls Alone			
BLS	0.86	480	48
BMS	0.81	440	81
BHS	0.79	430	96
Bulls + Goats			
GLS	0.84	460	63
GMS	0.88	480	44
GHS	0.86	470	48
Sig	**	**	
LSD 0.01	0.05 0.06	15 20	

The liveweight gain data (November - mid January over 2 years) is reflected in the average liveweight of bulls at time of sale. Bulls on the BHS treatment had a sale liveweight 50kg less (P<0.01) than the BLS treatment and the GMS and GHS treatments had a similar liveweight at sale as the BLS treatment and greater (P<0.01) than the BMS and BHS treatments. In no treatment did 100% of bulls reach the target liveweight of 475kg at sale. For the BLS, GMS and GHS treatments about 50% of the bulls reached target but in the BHS treatment only one bull (4%) over the three years made target liveweight.

The graphs presented in Figure 1 and Figure 2 of the average liveweight gains/day for the bulls alone treatments and the bull and goat treatments respectively show the stocking rate effect of bulls alone was most apparent over summer and autumn when the higher stocked treatments had a lower

FIGURE 1: Effect of increasing stocking rate of bulls grazed alone at low stocking rate (BLS •_•), medium stocking rate (BMS o——o) and high stocking rate (BHS, •——•) on the average liveweight gain/day of bulls over the 3-16 month of age period.

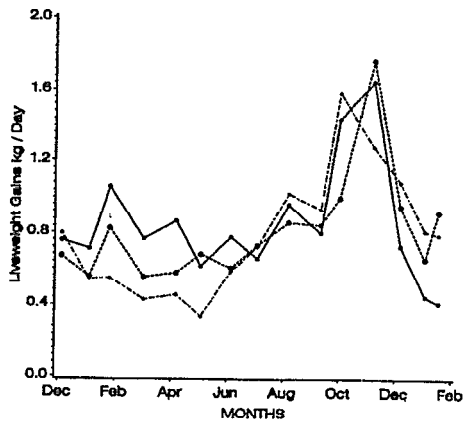
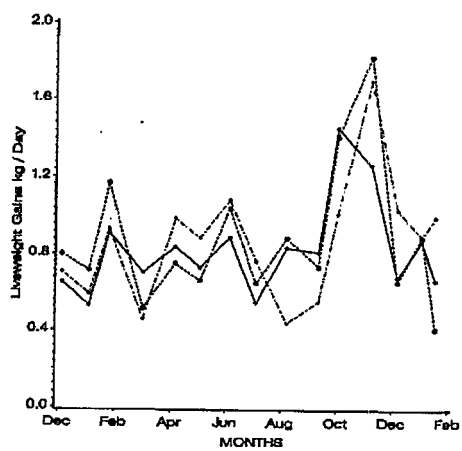


FIGURE 2: Effect of adding additional angora does; at a low goat stocking rate (GLS •_•), medium goat stocking rate (GMS o——o) and a high goat stocking rate (GHS, •——•) to bulls stocked at 3 bulls/ha on the average liveweight gain/day of bulls over 3-16 month of age period.



(P<0.01) daily liveweight gain than the BLS treatment. Over spring no stocking rate effect on liveweight gain is apparent and the tendency in spring is for the higher stocked treatment to have a higher liveweight gain over spring.

This effect became more marked in January and February when both the BHS and GHS treatments had higher (P<0.05) liveweight gains than the respective LS treatments. Each year in July and August liveweight gain on the GHS treatment was significantly lower than the GMS treatment (P<0.05) and lower (P<0.01) than the other four treatments. No differences were observed in liveweight gains between the other goat treatments and bulls alone treatments.

Increase in the stocking rate of goats reduced doe liveweight at mating (P<0.05) for the GHS treatment (Table 3). Kid liveweight at weaning showed a linear decline (P<0.01) with increasing stocking rate of does. No effect of increasing stocking rate on the fleece weight of does or kids was recorded.

Table 4 summaries all the animal production data recorded by expressing treatment effect as the amount of saleable product on a /ha basis. From Table 4 it is possible to

TABLE 3: Goat performance: average doe and kid liveweight and kid fleece weights over three years and doe annual fleece weight over two years.

Treatment	Doe Lwt (kg) March	Kid Lwt (kg) Weaning	No. Kids Weaned	Doe Fleece Wt (kg)	Kid Fleece Wt (kg)
Bulls + Goats					
GLS	35	14.7	10	3.1	0.56
GMS	34	13.5	14	3.0	0.55
GHS	32	12.1	27	2.9	0.52
Sig.	*	**		NS	NS
LSD 0.05	2.0	1.5		-	-
0.01	-	2.0		-	-

TABLE 4: Yield of saleable products from bull alone and bull + goat systems (kg/ha).

Treatment	Liveweight			Fleece Weight	
	Bull	Kid	Does*	Kid	Doe
Bulls Alone					
BLS	1130	-	-	-	-
BMS	1330	-	-	-	-
BHS	1570	-	-	-	-
Bulls + Goats					
GLS	1110	50	35	2	10
GMS	1140	60	57	3	21
GHS	1120	110	107	5	40

* Cull does

calculate gross margins (Table 5) for any of the management systems represented in the trial. This showed all treatments had a similar gross margin of around $700/ha.

TABLE 5: Gross Margins ($/ha), calculated from the outputs presented in Table 4.

	Bull Revenue	Goat Revenue	Total Cost	Gross Margin
BLS	1830		1140	690
BMS	2100		1440	660
BHS	2490		1760	730
Bulls + Goats				
GLS	1800	100	1200	700
GMS	1820	170	1270	720
GHS	1790	280	1350	720

The estimate of gross margin however would vary markedly by the relative prices for processed bull beef, store bulls, goat meat, mohair and the interest rate on borrowed money at the time calculations were made. Estimates of relative profitability of any system for any particular economic situation is however possible from the data presented in Table 4.

Because of the limited number of paddocks (4/treatment) and at times having up to 3 animal groups/treatment, continuous rates of pasture accumulation for every paddock could not be obtained. However for a particular treatment at any particular time it was possible to obtain pasture accumulation rates for at least one paddock. The information presented in Table 6 is a summary of the annual DM production for each treatment calculated from weekly assessments of

TABLE 6: Average annual pasture production.

	kgDM/ha
Bulls Alone	
BLS	9520
BMS	10923
BHS	9170
Bulls + Goats	
GLS	9470
GMS	10300
GHS	11520

DM accumulation rates. For the bull and goat treatments there is a tendency for DM production to increase with increasing stocking rate of goats. This trend is not apparent with increasing stocking rate of bulls in the bull alone treatments.

DISCUSSION

From the interrelationships between different farm inputs and product output as described by Harsh *et al.*, (1982) it is assumed from the data presented in Tables 2 & 3 that the addition of Angora does do not have a complementary effect on bull beef production. Also the addition of goats, even at 14 does/ha to a bulls beef system are not competitive on bull beef production. From this it is assessed that Angora does have a supplementary effect; ie. the amount of goat products can be increased (Table 5) without any decline in bull beef production. Over winter (Figure 1) does stocked at 13/ha were competitive ($P<0.01$) with bulls but when all seasons are taken into account does at the higher stocking rate had no effect on the level of beef production from bulls stocked at 3 bulls/ha.

Mohair production is reported to be insensitive to level of nutrition (Shahjalal *et al.*, (1992). This is reflected in this study in that liveweight of does and kids at the high stocking rate were significantly lighter than the lower stocked treatments but no effect on the individual mohair production for either does or kids was apparent (Table 3). In New Zealand the relative values of chevon and mohair are in the order of 1 : 5. With this pricing structure the effect of stocking rate on financial returns/doe would be minimal. From the information presented in Table 3 on doe and kid performance, especially considering mohair production, it could be assumed that a system of 3 bulls and 13 does/ha (26 su/ha) was a sustainable production system. Increasing the stocking rate

of bulls alone above 3/ha (15 su/ha) resulted in a decline in liveweight at sale (Table 2) and an increase in the number of bulls sold as "stores". Over the period the trial was run, 1989 - 1992, the value of "store" bulls/kg liveweight was the same as the schedule value. However if these values were to change and result in a relative drop in "store" price the bull alone system stocked at 18-23 su/ha would be less profitable than the BLS and the bull/goat systems irrespective of goat stocking rate.

Everitt and Ward (1974) concluded from a series of trials on stocking rate effects on bull beef production that the maximum profit/ha is achieved at a stocking rate 20-25% below that which produced the maximum beef/ha. In Table 5 it is shown that total liveweight of bulls sold/ha increased over the three bull alone stocking rate treatments. From this it could be concluded for the location of the trial the optimum bull stocking rate for maximum profitability from bulls alone would have been greater than 3 bulls/ha.

Information presented on pasture production, (although expressed as trends only) shows a similar effect (30% increase in DM production) as recorded on goat grazed pasture when compared with sheep grazed pasture by Clark *et al.*, (1984). The higher DM production of the goat treatments compared with the bulls alone treatments is reflected by the high level of animal production (Table 4) in relation to the number of stock units carried. The increased DM production on the treatment with the high stocking rate of goats could be possibly due to two factors; pasture being maintained at a higher height than the higher stocked bulls alone treatment (Clark *et al.*, 1984, Collins and Nicol 1986) resulting in a higher photosynthetic surface area; or a higher utilisation of long pasture than would occur on the BLS treatment, resulting in the maintenance of the total sward canopy at an optimum height for growth due to the elimination of pasture clumps.

CONCLUSION

Increasing stocking rate on a bull beef system by increasing the number of bulls, resulted in a significant reduction in liveweight gain indicating competition. Increasing the stocking rate by adding Angora does resulted in no effect on bull beef production, indicating that the mixed grazing system had a supplementary effect on overall animal production. No complementary effect of grazing goats with bulls was observed. The overall benefit of a bull beef/Angora doe system would depend on the relative values of bull beef and mohair. From the trial results it is concluded that a mixed grazing system of 3 bulls/ha and between 7 and 13 Angora does/ha, total carrying capacity of 18-26 su/ha was a more sustainable production system than similar stocking rates of bulls alone.

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