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Contents

Summary

Systems of utilizing tall fescue pasture for increased lamb production were tested in two years of grazing trials at Morgantown, West Virginia. One system involved grazing of fescue with ewes and lambs from May to August at three levels of fescue dry matter availability (1000, 2000, 3000 lb per acre). A second system provided alfalfa-brome pasture by creep gates to lambs, with controlled strip grazing and harvesting of surplus forage as hay. Increasing the availability of fescue in both systems improved the quality of herbage, increased intake and reduced weight losses by ewes. Liveweight gains by lambs in the no creep system were also improved by increased herbage allowance but rates of gain per head were low. Conversely, lamb production per acre at the lowest dry matter allowance was relatively high (mean adjusted gains of 328 lb per acre). Lambs in the creep grazing system had higher levels of dry matter intake than lambs on fescue (seasonal means of 2.0 vs 1.5 lb per day) and intake tended to decline as level of fescue allowance to the ewes increased. Lambs in both systems showed equivalent daily gains (.42 to .43 lb per day) during the first three weeks of grazing, after which daily gains in lambs on creep were markedly higher than in lambs on fescue. Seasonal rates of gain of lambs with creep grazing averaged .36 lb per day compared to an average of .19 lb per day without creep. Adjusted liveweight gains of lambs per acre on a creep grazing system were higher than without creep (means of 345 vs 242 lb per acre, respectively), and production per acre decreased with increasing fescue availability. Results, in terms of lamb daily gain and output per acre, favor provision of high quality creep pasture to lambs combined with low availability of fescue pasture to the ewes. It was noted, however, that heavy grazing of fescue pastures resulted in a loss of fescue in the third year. Calculation of gross returns appears to justify use of a creep grazing approach in improving utilization of tall fescue pastures in spring and summer for lamb production.

Creep Grazing Lambs on Tall Fescue Pastures

C.C. Adandedjan, R.L. Reid, Teal S. Ranney
and E.C. Townsend

Introduction

A national forage journal recently referred, in one of its lead articles, to "poison fescue." This is a paradoxical situation for a grass which is probably more widely grown for pasture, hay production and conservation than any other species in the United States. The "poison" connotation arose in the mid 1970's with the demonstration that the "summer slump" or "summer syndrome" of cattle grazing fescue—poor weight gains, depressed herbage intake, low milk production, high rectal temperatures and rough hair coats—was associated with the presence in the grass of an endophytic fungus, *Acremonium coenophialum.* It was shown by Kentucky workers (Boling et al., 1983; Buckner et al., 1983; Boling, 1985) that infected fescue contains elevated concentrations of pyrrolizidine (loline) and diazaphenanthrene (perloline) alkaloids, but it is not clear whether the alkaloids are toxic, whether the toxins are produced directly by the fungus or by interaction of the endophyte with tissue of the host plant, or indeed what the mode of action is. It is of interest, however, that a similar (or identical) endophytic fungus, *Acremonium loliae,* found in perennial ryegrass pastures in New Zealand, results in higher levels of another series of compounds, lolitrems, in the plant (di Menna and Waller, 1986). These are associated with the syndrome of ryegrass staggers, a quite different neurological disorder, in grazing sheep, cattle, horses and deer.

It has been clearly demonstrated that the performance of ruminant animals, sheep or cattle, grazing endophyte-infected tall fescue pastures during the summer is depressed. Earlier feeding trials in West Virginia with tall fescue fed as cut herbage or hay to wether lambs (Reid and Jung, 1965 a,b), or grazed under different fertilization treatments (Reid et al., 1967), showed that while chemical composition and digestibility of fescue were similar to those of other temperate grasses, level of intake was low. Grazing trials with early-weaned lambs (Reid et al., 1978) gave lower seasonal average daily gains (ADG) of .18 lb/day on Kentucky 31 tall fescue, compared to perennial ryegrass (.24 lb/day), orchardgrass (.26 lb/day) or smooth brome (.33 lb/day). Growth rates of lambs related fairly consistently to estimated intakes of digestible dry matter. However, it was also noted (Powell et al., 1978) that lambs fed tall fescue in balance trials utilized certain minerals less efficiently than lambs fed other grass species. Gains in lambs were markedly improved by the incorporation of red clover in tall fescue pastures (Breedlove, 1982), and

similar responses to legumes have been noted for steers and for cow-calf pairs (Hoveland et al., 1981; Holloway and Butts, 1983).

The "summer slump" in beef cattle has been related in several studies to the grazing of endophyte-infected tall fescue (Bacon et al., 1977; Schmidt et al., 1983; Hoveland et al., 1983; Boling et al., 1983). One approach to alleviating the problem has been to graze cultivars of fescue or fescue hybrids low in or free of the endophyte (Stuedemann et al., 1985; Read and Camp, 1986). This has the obvious limitation that much of the existing tall fescue in the United States is already infected (Robbins, 1983). However, ADGs of cattle grazing low-endophyte fescues have been found to be significantly higher than gains of cattle on fescue containing high levels of the endophyte.

A frequent interpretation of such results is that endophytic fescue pastures should be renovated or replaced by endophyte-free material. This may not be practical or even warranted, at least in some management systems. One unresolved question is whether endophyte-free pastures are more susceptible to insect damage and show depressed yields or problems in establishment. Under New Zealand conditions, for example, Prestidge et al. (1982) showed a high association between presence of an endophyte in ryegrass and resistance to stem weevil attack. Barker et al. (1983) found that the endophytes of ryegrass and tall fescue had the same effect in reducing weevil feeding behavior, while Funk et al. (1984) observed a positive effect of the presence of endophytic fungi (*Acremonium spp.*) on summer growth, fall recovery, persistence and resistance to weed incursion of tall fescue and ryegrass in New Jersey.

The other, and primary, argument against an overall replacement policy is that tall fescue in its present form is an outstanding "carrying" grass in livestock systems where maintenance nutrition is a desideratum at certain times of the year. The value and use of tall fescue as stock-piled herbage or hay for the maintenance of beef cows and ewes in late fall and winter has been widely accepted (Van Keuren, 1976). A common practice in the eastern United States is to take off one or two cuttings of fescue as large round hay bales, fertilize the pastures with nitrogen (N) in August and accumulate the regrowth for grazing before the end of the year, followed by bale feeding in late winter. An alternative management in cow-calf or ewe-lamb operations would be to use fescue pastures in spring and summer at high grazing pressures to provide maintenance feeding for the cow or ewe, with supplementary nutrition to the calf or lamb through creep grazing or creep feeding (Blaser et al., 1976; Matches and Burns, 1985). This approach has been tested in cow-calf management systems at the Station's Reedsville Experiment Farm (Vicini, 1980).

The objectives of the present trials were: (1) to compare lamb performance and production per acre in two grazing systems, one a standard management in which lambs remained with the ewes on fescue pastures during spring and summer, and the other in which high quality creep pasture was available to the

lambs; (2) to determine the most appropriate herbage allowance—or ewe stocking density—to maximize utilization of the fescue without detrimental effects on subsequent ewe performance (breeding) or persistence and composition of the pasture. Emphasis in grazing management studies in recent years has changed from definition of stocking rates or densities to control of sward characteristics (mass, height), and the effects which these may have on pasture growth, composition and persistence, and on animal grazing behavior and the intake and quality of ingested herbage (Jamieson and Hodgson, 1979; Meijs, 1983; Hodgson, 1982, 1985; Black and Kenney, 1984; Stockdale, 1985). Within each grazing system, therefore, pasture size was adjusted to provide three levels of herbage availability, and responses were measured in terms of pasture production and herbage digestibility, intake and liveweight changes of ewes and lambs during the grazing season. An attempt was also made to intrepret responses in terms of relative costs of alternative systems to the farmer.

Experimental Procedures

Grazing trials were conducted in 1983 and 1984 on a sloping 45-acre site on the Plant Sciences Farm, Morgantown, West Virginia. Soils are predominantly Gilpin silt loam, a member of the fine loamy, mixed, mesic family of Typic Hapludults. Mean soil pH on the experimental pastures at the beginning of trials was 6.2 and soil P and K status was moderate to high. Climatic data for the area are given in Appendix Table 1, together with long term means taken over a 22-year period (USDA and WVU, 1982).

Pastures (1.5 to 2 acres) were allocated at random from five established stands of Kentucky 31 tall fescue to two grazing systems. Figure 1 gives a graphical layout of the treatments. The pastures initially contained small proportions (<10%) of white clover and weed species, by visual estimate. Two replicates were assigned to a standard management system, in which ewes and lambs grazed the pastures from May to August. Three replicates were assigned to a creep grazing system, in which lambs were provided access by a creep gate to adjacent pastures of alfalfa—smooth bromegrass, seeded in 1982. The creep pastures at the beginning of the trials contained 60 percent alfalfa and 40 percent bromegrass, rated visually.

Within systems, each tall fescue pasture was divided into three subplots to which different intensities of grazing, designed to maintain swards carrying different herbage dry matter (DM) masses (1,000, 2,000, 3,000 lb/acre), were imposed randomly. This was achieved by altering plot size, with equal numbers of animals, rather than by varying animal numbers on equal sized plots. In the creep grazing system, each alfalfa-brome pasture (1.5 acre) was divided equally into three subplots, with each plot connected by a creep gate to the appropriate tall fescue treatment. The creep pastures were cross-fenced with mesh electric fencing to permit strip grazing of the pastures.

Nitrogen (as ammonium nitrate) was applied to the tall fescue pastures each year at the rate of 100 lb per acre, in split treatments in late March and June. Pastures were topped twice mechanically during the summer to remove seed heads and to promote tiller development. Surplus growth on the ungrazed creep areas was cut twice each year, baled and weights were recorded. Weights of surplus forage were converted to lamb growth units and used in calculation of 'adjusted' lamb liveweight gains per acre in the creep management system. Conversions were made based on results of previous feeding trials in which 50 to 60 lb lambs consuming 3.5 lb alfalfa hay of equivalent digestibility gained .35 lb liveweight per day.

Ewes were mature animals of Suffolk and Suffolk X Dorset breeding. They were mated, using synchronized estrus, to Dorset and Suffolk rams in late October each year. Mean dates of lambing were April 2 in 1983 and April 9 in

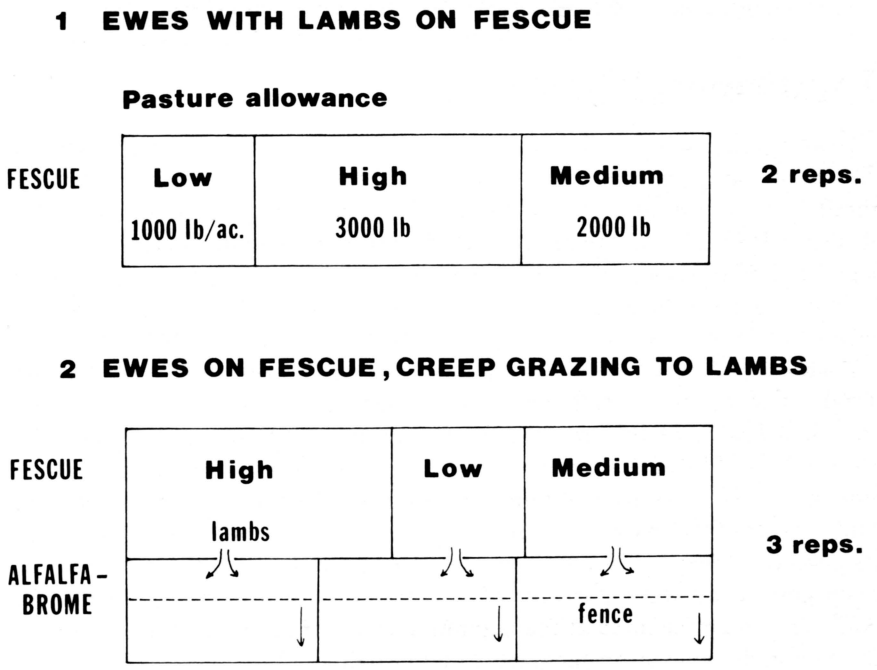

Figure 1. Diagrammatic plan of design of experiment.

1984. Male lambs were castrated and all lambs were docked within 14 days of birth and vaccinated for enterotoxemia before going on pasture. Groups of ewes and lambs were balanced for date of birth and for single vs twin lambs and were randomly allocated to pasture treatments. Mean weights of lambs at the beginning of the grazing trials were 31 lb in 1983 and 22 lb in 1984.

Each tall fescue pasture was grazed continuously from May to August. Grazing began on May 16 in 1983 and on May 10 in 1984. Within a field the

number of experimental animals per subplot was the same, with each subplot carrying four or five ewes with their lambs. Herbage DM allowances of 1,000, 2,000 and 3,000 lb/acre were further adjusted, if necessary, by the intermittent addition of dry ewes kept on reserve fescue pasture. Routine health measures included drenching ewes and lambs every 21 days with an anthelmintic (Tramisol, Thiabendazole, alternately), and trimming and treating feet with a 10 percent formalin solution. Animals had free access to plain salt blocks and drinking water.

Due to dry weather in July and August of 1983 (Appendix Table 1), pasture growth was interrupted and ewes on the low and medium availabilities in the no creep system were fed weighed quantities of grass hay for a 21-day period in July–August to prevent excessive weight loss. Ewes in the creep system at the same availability levels were allowed to graze creep pastures for the same period. Weight changes of ewes during this period were excluded from the data base in 1983.

Pasture mass and height on each subplot were measured at the beginning of the trials and at 21-day intervals thereafter, using a disc meter. Samples for DM and yield determinations were collected at a clipping height of 1 inch. Herbage samples, selected to represent ingested material, were taken from all subplots by a hand plucking technique in early June and July each year. Samples were dried in a forced air oven at 65°C, ground in a Wiley mill through a 1 mm screen and analyzed for in vitro dry matter disappearance (IVDMD) by the procedure of Tilley and Terry (1963) as modified by Barnes (1967), neutral detergent fiber (NDF) by the method of Goering and Van Soest (1970), and crude protein (AOAC, 1975).

Following the two years of grazing trials, botanical composition of tall fescue pastures was determined in late April, 1985, by hand separation and weighing of clipped samples. These data were used to measure residual effects of varying grazing intensities on pasture composition.

Intake of herbage by ewes and lambs was estimated at two periods (early June and July) each year, using a fecal indicator technique as described by Langlands (1974). Three ewes and three lambs on each subplot were dosed with 2 grams Cr_2O_3 in gelatin capsules twice daily at 08.30 and 15.30 hours for nine days. Fecal grab samples were collected per rectum during the last five days of each period at the time of dosing. Composited samples were dried in a forced air oven at 65°C, ground through a 1 mm screen and Cr_2O_3 concentrations determined by the method of Stevenson and de Langen (1960).

It was noted in the 1983 trials that lambs at different levels of herbage mass in the creep grazing system showed different grazing behaviors. Consequently, in 1984 observations on grazing activity were made by recording the proportion of time individual lambs spent on the creep pastures from daylight to darkness on two consecutive days. These data were also used to adjust calculations of intake by creep grazed lambs, using weighted means of IVDMD values determined for the alfalfa-brome and tall fescue pastures.

Weights of ewes and lambs were taken, without overnight fasting, at 21-day intervals during each grazing season. Weights were used to calculate ADG of ewes and lambs by period (0–21, 21–60, 60–final, days) and for the grazing season. Lamb production per acre was estimated as actual and 'adjusted' values. The latter included estimated gains from harvested alfalfa-bromegrass in the creep grazing system.

Pasture design was a 2 × 3 split plot. Standard analysis of variance (AOV) for a split plot design, using a general linear models procedure (Barr et al., 1979), was performed to examine effects of management system and herbage availability on pasture and animal responses over time. Fisher LSD or Duncan's multiple range tests were used to compare means where AOV showed significant differences. Trend comparisons were made using orthogonal polynomial analysis to define functional relationships between herbage availability levels and treatment means.

Results

Pasture Availability. Amounts of tall fescue pasture available to the ewes at three levels of herbage allowance are shown in Figure 2. The pattern of pasture growth and availability was different in the two years of the study. As noted, there was a drought during the summer of 1983 (Appendix Table 1). Pasture dry matter, averaged over all allowances, was higher during the first month of grazing trials in 1983 than in 1984 and then declined steadily to a residual level of 846 lb DM per acre. Dry matter available in 1984 increased to the sixth or seventh week and then declined to a residual level of 1210 lb per acre. Grazing system (no creep vs creep) had no effect ($P>.05$) on herbage availability. Mean DM yields for all periods of the trials were 1657 and 2024 lb DM per acre for the no creep and creep systems, respectively.

The objective of the stocking adjustments was to maintain uniform herbage mass availabilities of approximately 1000, 2000, and 3000 lb DM per acre during the grazing season. Combined estimates for 1983 and 1984 show mean fescue DM levels of 1160, 1762 and 2490 lb DM per acre ($P<.01$) for the low, medium and high grazing allowances, respectively. There was a significant interaction of herbage allowance with period. At low allowance, herbage mass declined steadily during the grazing season, while pasture DM at medium and high allowances increased to the third or fourth week before decreasing.

As expected, the same trends were observed for pasture height as for herbage mass. Herbage height declined from the first to the last week of grazing in both management systems, but the rate of decrease was greater in the no creep compared with the creep grazing system. The availability effect was significant ($P<.01$), with no interaction with system or period. Mean pasture heights were 3.4, 4.2 and 5.2 inches for low, medium and high availabilities, respectively.

SEASONAL CHANGES IN FESCUE AVAILABILITY

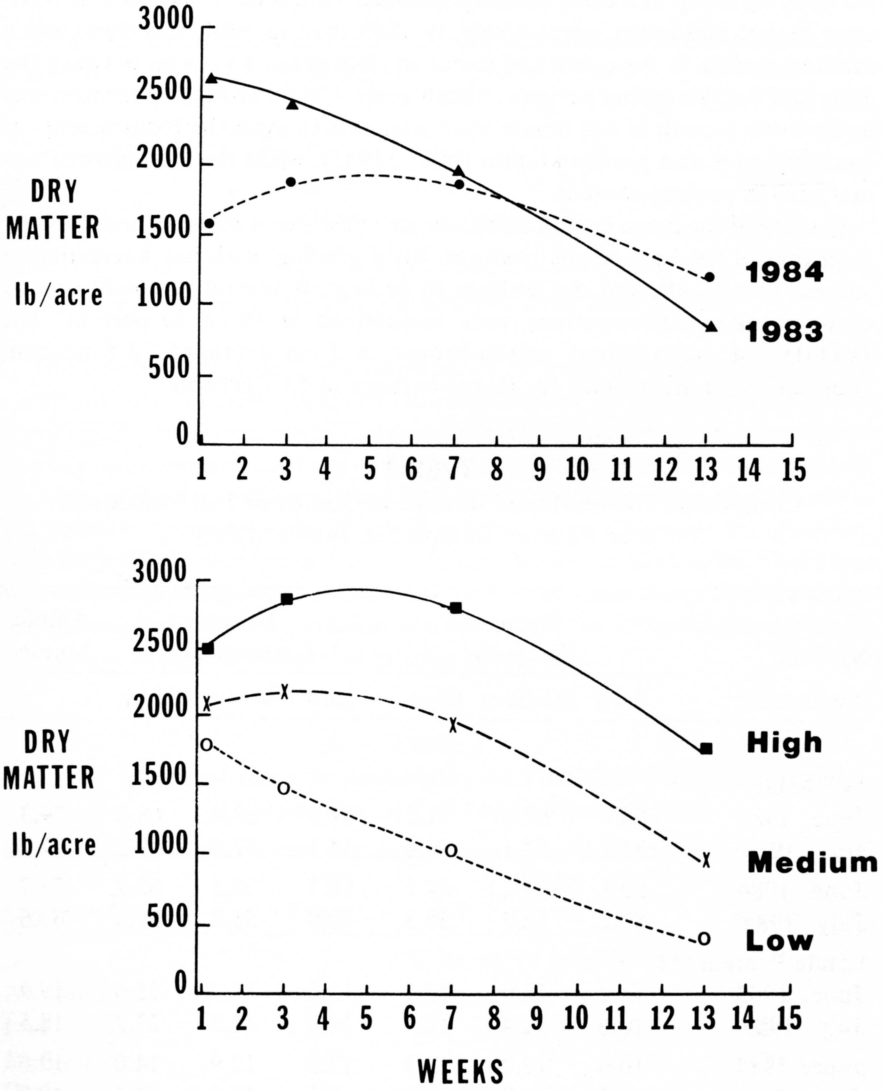

Figure 2. Dry matter available on tall fescue pastures by year and by management (systems combined).

Pasture Composition and Quality. In vitro DMD, crude protein, and NDF values for herbage sampled from tall fescue and alfalfa-brome creep pastures at two periods in 1983 and 1984 are given in Table 1. Quality of the fescue was significantly affected by the amount of herbage available on the pasture, as indicated in Table 2. In vitro DMD and crude protein increased linearly with

increasing herbage availability, while NDF concentration decreased. There were no differences ($P>.05$) in composition or quality of the tall fescue between no creep and creep grazing systems. Values for IVDMD and NDF were higher and lower, respectively, in 1983 than in 1984, and there was a marked decline in the quality of fescue in both grazing systems between the June and July sampling periods in both years. Crude protein concentrations in the June growth of tall fescue were adequate to meet the requirements of lactating ewes and growing lambs (NRC, 1985), while the July growth was marginal in protein content.

Quality of the creep grazed alfalfa-brome pastures was considerably better than that of the base fescue pastures. Strip grazing, with hay harvesting of surplus forage, allowed the herbage to be kept in vegetative condition and crude protein concentrations were maintained at 18 to 20 percent. The IVDMD of creep-grazed alfalfa-brome in June averaged 78.5 percent, compared to a mean value for fescue herbage of 63.7 percent.

Table 1

Composition (Oven-Dried Basis) and Quality of Tall Fescue and Creep Pastures Sampled in June and July.

System:	Fescue No creep			Fescue Creep grazed			Alfalfa-brome
Availability:	Low	Medium	High	Low	Medium	High	
				%			
IVDMD*							
June, 1983	66.7	67.6	71.5	61.5	63.4	68.6	79.3
July, 1983	55.1	57.1	60.4	54.1	57.6	59.2	77.2
June, 1984	59.1	62.2	64.1	56.7	59.3	63.8	77.7
July, 1984	50.2	52.7	55.5	49.0	55.8	59.4	65.6
Crude Protein*							
June, 1983	13.2	14.0	16.7	13.0	14.0	15.6	19.9
July, 1983	10.6	12.4	14.7	10.4	11.3	12.2	18.5
June, 1984	10.6	12.2	12.7	12.2	12.9	14.0	19.6
July, 1984	9.3	10.7	11.1	9.1	10.2	11.1	18.2
NDF*							
June, 1983	55.7	54.9	51.7	55.8	54.6	53.0	43.2
July, 1983	64.3	62.6	58.6	67.4	65.2	63.7	46.3
June, 1984	65.0	62.5	60.3	63.7	62.4	61.1	48.0
July, 1984	71.6	68.1	67.0	70.9	71.0	66.4	55.4

*Values are means of hand-plucked samples from pasture replicates.

Table 2
Effect of Herbage Availability on Quality of Tall Fescue Pasture (Oven-Dried Basis).

Factors:	IVDMD	Crude Protein	NDF
		%	
Availability:			
Low	56.3[a]	11.1[a]	64.3[a]
Medium	59.4[b]	12.2[b]	62.8[a]
High	62.8[c]	13.5[c]	60.0[b]

[a, b, c]Means with different superscripts are different ($P<.05$) by Fisher's LSD.

The effects of different availabilities of herbage on post-trial botanical composition of tall fescue pastures are summarized in Table 3. At the end of April, 1985, there were no differences ($P>.05$) between pasture components due to grazing system, but level of availability did alter botanical composition. As herbage mass was reduced from high to low, the proportion of tall fescue in the pastures decreased from 98 to 55 percent of total herbage composition, with the greatest decrease between medium and low availabilities. There was some accompanying increase in the proportion of white clover, but the major change resulted from the invasion of different species of broad-leaved weeds in pastures kept under intensive grazing pressure.

Table 3
Effects of Herbage Availability on Post-Trial Botanical Composition of Tall Fescue Pastures.

Components:	Tall Fescue	White Clover	Weeds
		% by wt. of total forage	
Availability:			
Low	55[a]	6[a]	39[a]
Medium	90[b]	1[b]	9[b]
High	98[c]	1[b]	1[b]

[a, b, c]For each component, means with different superscripts are different ($P<.05$) by Fisher's LSD.

Intake by Ewes and Lambs. Data for estimated dry matter intakes by ewes and lambs in the two grazing systems, as affected by level of herbage availability and period of grazing, are summarized in Table 4. Major significant effects are illustrated graphically in Figures 3 and 4.

Table 4

Intake by Ewes and Lambs at Different Levels of Herbage Availability in Two Grazing Systems.*

	1983				1984			
	Ewes		Lambs		Ewes		Lambs	
Availability	June	July	June	July	June	July	June	July
	lb DM/day							
No Creep								
Low	3.12	2.64	1.38	1.24	2.82	2.68	1.16	1.20
Medium	3.55	3.14	1.70	1.50	3.40	3.01	1.35	1.31
High	4.49	3.61	1.89	1.83	4.09	3.58	1.53	1.65
Average	3.72	3.13	1.66	1.52	3.44	3.09	1.35	1.39
Creep grazing†								
Low	3.01	2.48	2.17	2.25	2.69	2.60	1.88	2.16
Medium	3.40	3.06	2.12	2.29	3.33	2.99	1.72	1.98
High	4.25	3.23	1.86	2.10	3.75	3.68	1.60	1.88
Average	3.55	2.92	2.05	2.21	3.26	3.09	1.73	2.01

*Values are means for three ewes, three lambs per replicate.

†Intakes for lambs in creep system calculated from IVDMD's adjusted to percentage of time spent grazing fescue and alfalfa-brome pastures.

There was no difference in intake by ewes between the no creep and creep grazing systems (3.34 and 3.21 lb DM per day, respectively). Increasing the available herbage in both grazing systems resulted in a linear increase ($P<.01$) in intake of tall fescue, from a mean of 2.75 lb DM per day at low availability of pasture to 3.84 lb DM per day at high availability (Figure 3). Mean intake of fescue by ewes in June declined from 3.49 lb DM per day to 3.06 lb DM per day in July. While IVDMD levels of grazed fescue were higher in 1983 than in 1984 (Table 1), there were no differences in estimated intakes of pasture by ewes between years.

As would be expected, DM intakes by lambs differed ($P<.05$) between grazing systems as well as between herbage availability levels, and the two effects interacted ($P<.01$), as indicated in Figure 4. Intake by creep grazed lambs averaged 2.00 lb DM per day, compared to a mean value of 1.48 lb DM per day by lambs confined to fescue with the ewes, an average increase in intake on creep pastures of 35%.

The effect of level of fescue allowance differed ($P<.05$) between grazing systems. In the no creep system, intake by lambs increased with increasing herbage mass, as was observed for ewes (Figure 3). In the creep grazing system, however, the effect of availability on intake was not seen and there was, in fact, a consistent trend for herbage consumption by creep grazed lambs to decrease as availability of fescue to the ewe increased. This can be related to the fact that lambs from ewes grazing fescue pastures with a low herbage mass spent a greater proportion of the day on the creep areas than did lambs from ewes at higher levels of herbage mass. A difference in grazing behavior between single and twin lambs from ewes at medium and high availabilities was also observed. Twin lambs on these treatments spent a smaller proportion of the day on the creep pastures than did single lambs.

Performance of Ewes and Lambs and Lamb Production Per Acre. Liveweight changes of lambs during the grazing season (combined years) are shown in Figure 5, and weight changes of ewes and lambs as influenced by grazing system are summarized by period (0–21, 21–60 and 60 days–end of trials) in Figure 6.

Lambs in the no creep and creep systems had equivalent rates of gain (.42 to .43 lb per day) during the first three weeks of grazing. Thereafter, lambs in the creep system had significantly higher ADG than lambs confined to the fescue pastures, with lamb gains generally following patterns of DM intake. Differences in lamb ADG between no creep and creep grazing were greater in 1983 than in 1984, apparently relating to the greater buffering effect of high quality creep pasture on lamb growth during a dry summer with dwindling fescue pasture growth. Lambs on fescue pasture alone gained, on average, only .10 lb per day after the first three weeks of grazing, while lambs on creep grazing gained at a rate of .33 lb per day.

Ewes in both systems gained weight during the first three weeks of grazing, with a lower rate of gain in the creep than in the no creep system. Thereafter,

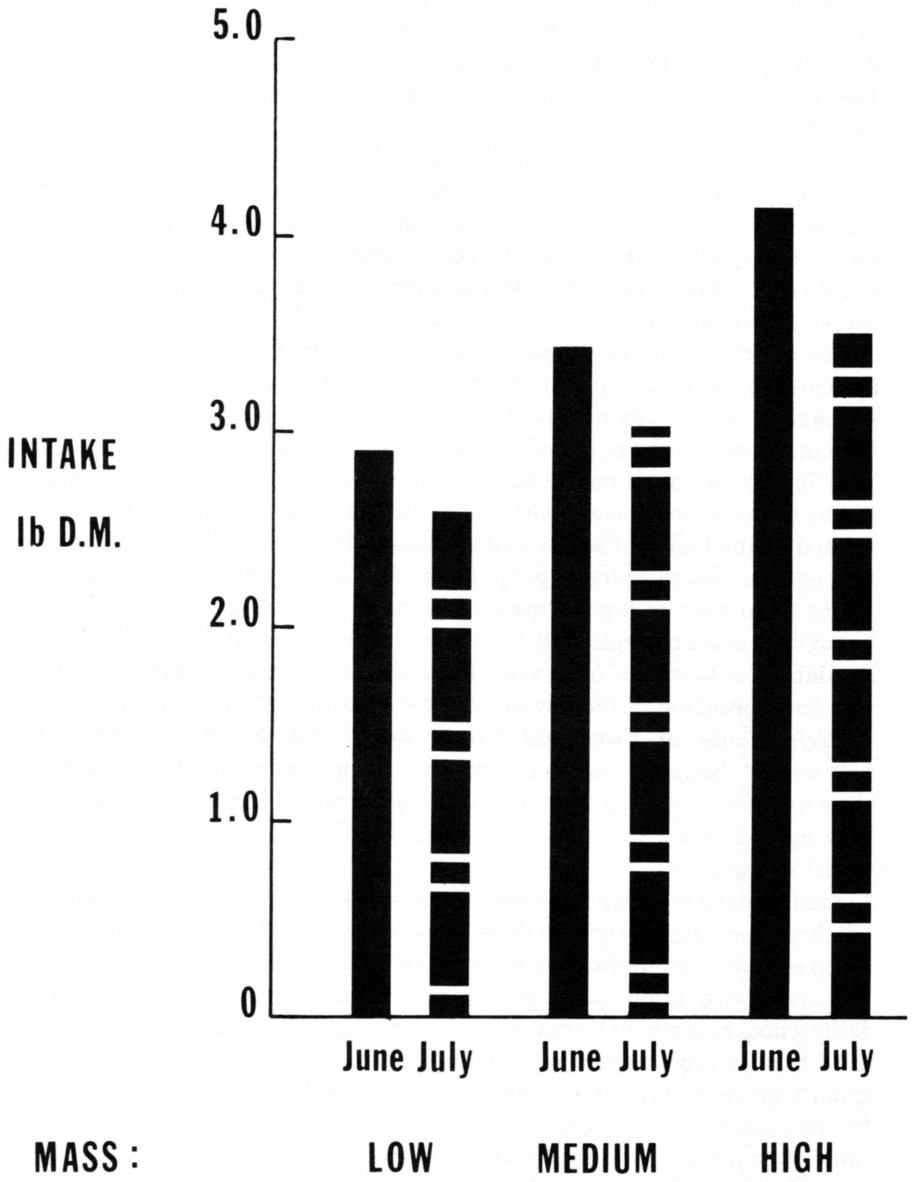

Figure 3. Intake of fescue by ewes in June and July as affected by pasture availability (systems combined).

SYSTEM EFFECTS ON INTAKE BY LAMBS

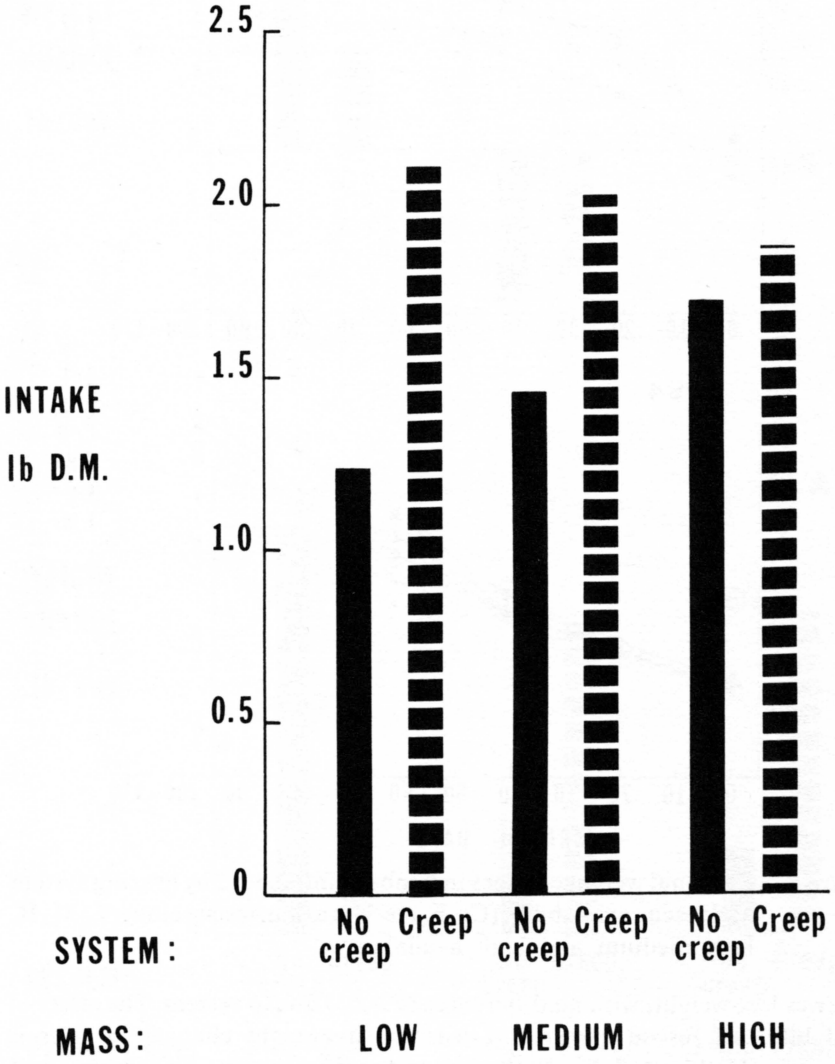

Figure 4. Dry matter intake by lambs in no creep and creep systems as influenced by availability of fescue.

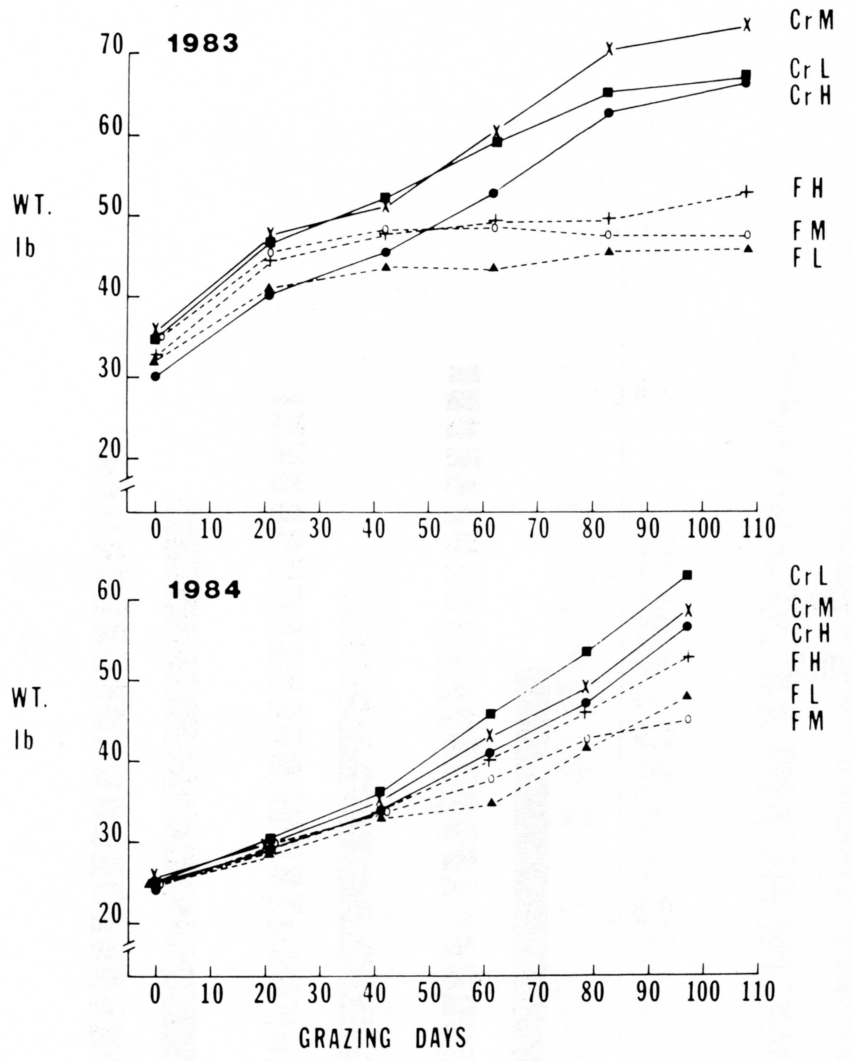

Figure 5. Seasonal weight changes in lambs as influenced by grazing system and fescue availability (Cr, F, creep grazing, fescue alone; L, M, H, low, medium and high availability).

the ewes lost weight, with no differences ($P>.05$) due to system. The effect of availability of fescue pasture on seasonal liveweight changes in ewes is summarized in Figure 7. For both years and grazing systems, ewes maintained at a low herbage allowance lost on average approximately .07 lb per day, compared to gains of .02 and .03 lb per day at medium and high allowances, respectively.

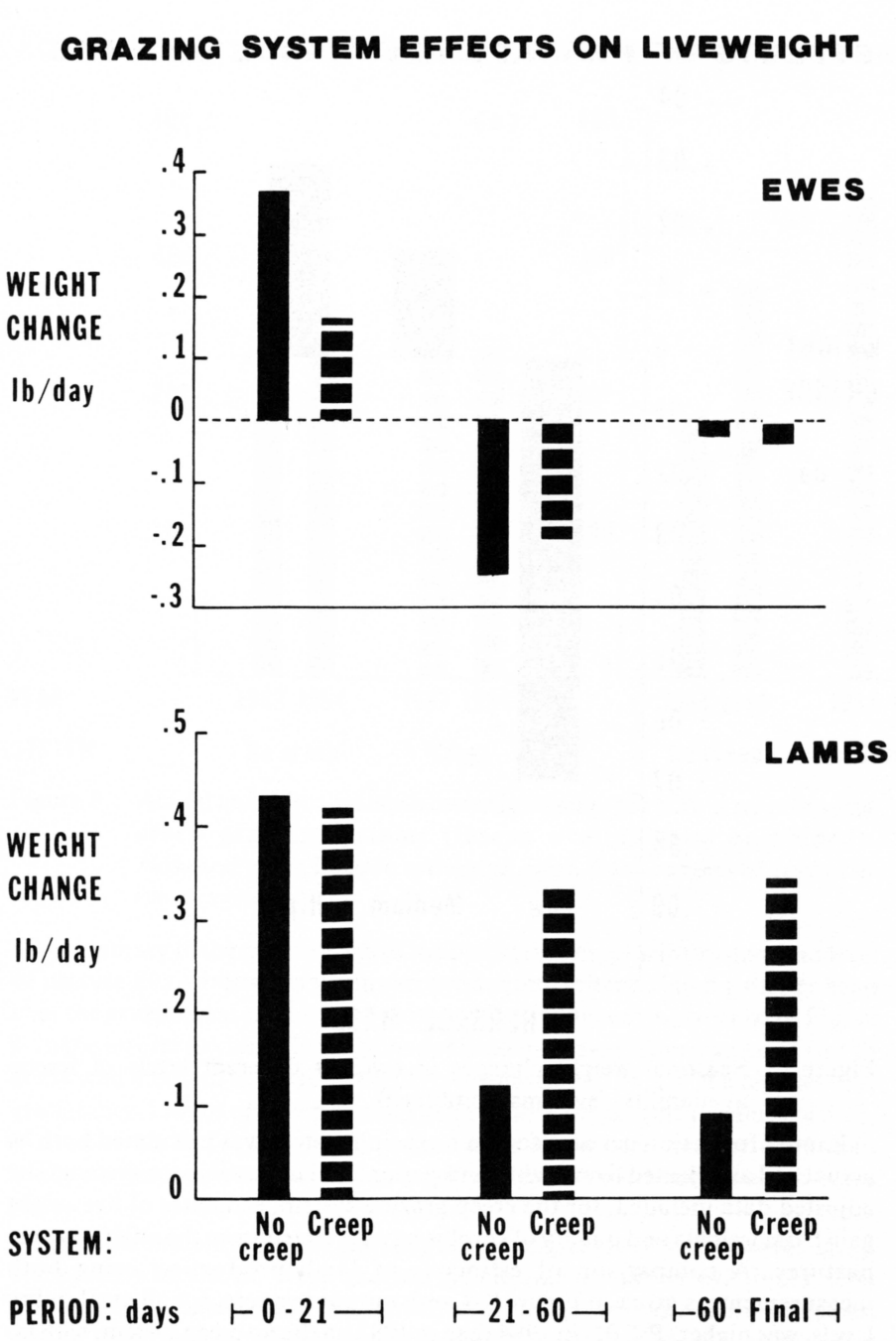

Figure 6. Period effects on weight changes in ewes and lambs in no creep and creep grazing systems (fescue availabilities combined).

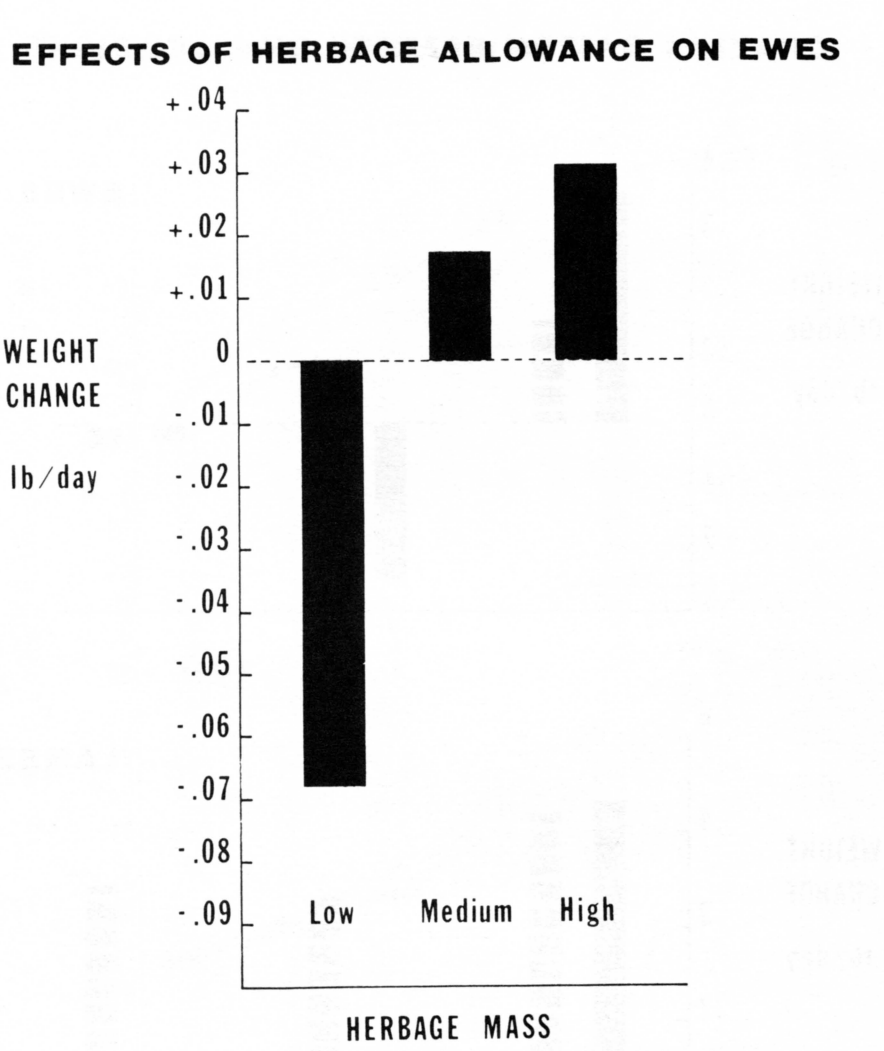

Figure 7. Seasonal weight changes in ewes at different levels of fescue availability (systems combined).

Lamb production per acre for each grazing system was calculated both as actual and as adjusted liveweight gains per unit of land used in the system. The adjusted data included, for the creep grazing system, estimates of liveweight gain from weights and quality of surplus hay harvested from the alfalfa-brome pastures. A comparison of estimates of lamb production using both measurements is given in Figure 8. Lamb output per acre, for all availability levels, was higher ($P<.01$) in 1984 than in 1983 on the no creep system, with no differences between years for creep grazing. Inclusion of estimated gains from conserved forage in the creep grazing system increased calculated lamb gains per acre from a mean of 250 to 340 lb per acre.

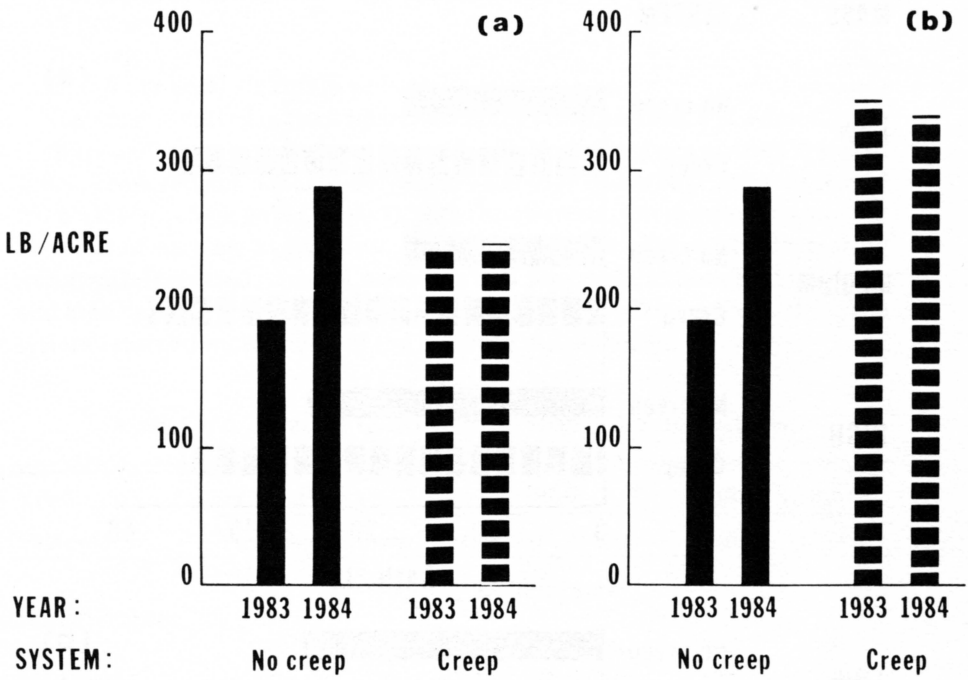

Figure 8. Actual and adjusted lamb liveweight gains per acre in no creep and creep grazing systems (fescue availabilities combined). Adjusted gains include estimated gains from conserved forage in creep system.

A summary of the main effects of the two variables, grazing system and level of pasture availability, on the major production criteria, lamb gain per head over the grazing season and lamb gain per acre (adjusted) is provided in Figure 9. In the no creep system, lamb gains per head increased from a mean of 16.1 lb at low and medium herbage levels of fescue pasture to 24.2 lb at a high level of availability. Lambs on creep grazing gained more weight (mean values of 35.2, 38.1 and 35.9 lb for low, medium and high allowances, respectively) than lambs on fescue pastures, with no difference ($P>.05$) between availability levels.

Adjusted lamb liveweight gain per acre was greater ($P<.05$) for the creep compared with the no creep grazing system (means 345 vs 242 lb per acre, respectively). Lamb gain per acre decreased as herbage mass increased ($P<.01$), with a significant interaction between system and availability. The rate of decrease, from 328 to 190 lb per acre in the no creep system, was greater than in the creep grazing management, from 382 to 200 lb liveweight gain per acre.

Figure 9. Seasonal liveweight gains in lambs by head (a) and per acre (b) as influenced by fescue availability and by grazing system.

Economic Evaluation of Systems. Actual and adjusted lamb gains per acre were expressed as returns based on an average selling price of $.60 per lb of lamb liveweight. Gross return (GR) from each management system was calculated as follows:

a. Creep system
   GR ($ per acre) = gain (lb per acre) × 60 c—added costs of creep pasture ($ per acre)
b. No creep
   GR ($ per acre) = gain (lb per acre) × 60 c

The items involved in the added costs of the creep pasture, and a description of the calculations, are given in Appendix Table 2. For both grazing systems, actual gross returns per acre decreased each year as herbage mass increased from a low to a high level (Table 5), with the no creep system returning more at all levels of herbage availability. For adjusted gross returns, the decreasing trend with increased herbage mass was still observed, although on medium and high herbage levels in 1983, and in the combined years analysis, the creep system returned more than did the no creep management.

Table 5
Actual and Adjusted Gross Returns from Grazing Systems.

Year:	1983		1984		Both years	
System:	No creep	Creep	No creep	Creep	No creep	Creep
			dollars/acre			
Actual returns						
Low	168	85	220	100	194	92
Medium	91	79	156	86	124	82
High	86	55	137	59	112	57
Adjusted returns						
Low	168	157	220	170	194	163
Medium	91	119	156	137	124	148
High	86	114	137	114	112	114

Discussion

Lamb production on hill regions in the northeast United States is generally from permanent pasture, often based on Kentucky bluegrass and/or orchardgrass, with varying amounts of white clover. Studies in the Allegheny Highland Project in West Virginia over a ten-year period showed typical ADG of .40 to .42 lb per day in lambs suckling ewes in a set stocking management on such pastures, and lamb liveweight gains of 200 to 250 lb per acre without supplementary feeding (B.S. Baker and P.E. Lewis, personal communication). Tall fescue is used mainly in late fall and winter as stockpiled herbage or as large round bales from spring and summer growth for the cow herd or ewe flock. A major objective of the present trials was to examine the alternative of grazing tall fescue to increase lamb production in spring and summer, with lambs weaned from the pastures in August, followed by N fertilization and stockpiling of the fescue for winter grazing.

The standard grazing system tested, that of set stocking ewes and lambs together on tall fescue, confirmed the general observations of low individual performance on fescue pastures infected with the endophytic fungus, but indicated the significant mediating effects of adjusting herbage mass available to the animals. Increasing the seasonal DM herbage availability from a mean of 1,160 to 2,490 lb DM per acre improved the quality of selected herbage and significantly increased the level of intake by both ewes and lambs, with a resulting improvement in liveweight gain or, in the case of the ewes, a reduction in weight loss as the grazing season progressed. Similar responses have been noted in other studies (Gibb and Treacher, 1976, 1978; Milne et al., 1981; Hodgson, 1982). However, even at the highest level of herbage availability, mean seasonal lamb ADG's were only .24 lb per day on fescue pasture, with a total liveweight increase of 24.2 lb per lamb. The data confirm results of an earlier study (Reid et al., 1978) showing seasonal ADG of .18 lb per day for early weaned lambs grazing Kentucky 31 tall fescue. These rates are markedly lower than those obtained on commercial farms in West Virginia. Decreasing available herbage by increasing grazing intensity reduced ADG still further, to means of .17 and .16 lb per day at low and medium herbage availabilities, respectively. However, while ADG were lower, increasing stocking pressure on the fescue pastures significantly increased lamb liveweight gains per acre, to 328 lb gain at the lowest level of herbage availability. This level of output per unit of land is higher than would normally be obtained on sheep farms in the region. The results illustrate again the general principle that any system of grazing management designed to maximize individual animal performance, by increasing pasture availability and opportunity for selection, will inevitably reduce animal production per unit of land. The sheep producer must decide which aspect of response he wishes to emphasize.

Introduction into the system of areas of higher quality creep pasture maintained in vegetative condition by controlled grazing and harvesting of excess forage markedly improved DM intake and ADG of lambs at all levels of herbage availability of the fescue pastures. Lambs on a creep system had an overall seasonal ADG of .36 lb per day compared with an average .19 lb per day without creep. This is comparable to gains obtained on farms with good permanent grass-legume pastures under lenient set stocking grazing management. Further, levels of lamb production per acre were consistently higher than those generally recorded for sheep farms in the region and were maximized, at an estimated 382 lb liveweight gain per acre, in a management which combined creep grazing of lambs with low fescue availability to the ewes. A creep grazing system also gave the advantage, in this study, of a feed reserve for the ewes when drought conditions during the summer limited growth of fescue pasture and caused excessive loss of body condition (more than 15 to 20 percent of starting weights). The differential weight losses, or gains, of ewes due to varying levels of herbage availability within both grazing

systems were not considered to be critical factors in these trials, since weight losses of the ewes were recovered by transfer to reserve grass-legume pastures or to sod-seeded cruciferous crops (rape, turnips) before mating in October. Breeding records showed no effect of grazing management on subsequent conception rates.

A number of creep grazing techniques have been tested with sheep. Based on results of these trials, a forward creep grazing approach would not be recommended for predominantly fescue pasture, but would probably work well with mixed fescue-legume swards. The sideways creep grazing method used, with access to high quality grass-legume pasture, gave good results in terms of both lamb daily gains and liveweight output per unit of land. The areas and facilities used for creep grazing could be modified considerably to reduce costs. Even so, a simple economic analysis of the data indicates that the additional allocation of land and investment in fencing would be justified in terms of returns. The optimum system appears to involve provision of good creep pasture combined with high grazing pressure on the fescue. A low availability of approximately 1,000 lb DM per acre was maintained in this study by stocking at the rate of approximately ten ewes with lambs per acre of fescue. This rate would need to be adjusted in relation to fertilization levels and seasonal patterns of herbage growth. The only detrimental feature of the high grazing pressure applied was a loss of tall fescue from the pasture after two years of trials. This effect, if consistent, would suggest modifying the grazing system either by some increase of herbage allowance or, possibly, use of rotational grazing management of the tall fescue pastures rather than the set stocking system employed.

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Appendix

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Appendix Table 1

Temperature and Rainfall Data Taken in Morgantown in 1983–84.

Variable	April	May	June	July	August	September
1983						
Temperature (°C)						
Maximum	11.6	17.3	23.2	25.6	25.4	20.9
	(17.5)*	(22.8)	(27.3)	(28.8)	(28.0)	(25.0)
Minimum	4.0	7.5	13.1	15.4	15.8	10.7
	(5.1)	(10.0)	(14.7)	(16.9)	(16.0)	(12.7)
1983						
Rainfall (in)	5.0	3.9	3.5	2.3	3.4	3.0
	(3.6)	(3.5)	(3.7)	(3.9)	(4.1)	(3.2)
1984						
Temperature (°C)						
Maximum	11.8	15.8	23.3	21.8	22.8	18.3
	(17.5)	(22.8)	(27.3)	(28.8)	(28.0)	(25.0)
Minimum	3.3	7.0	13.4	13.6	14.8	8.7
	(5.1)	(10.0)	(14.7)	(16.9)	(16.0)	(12.7)
1984						
Rainfall (in)	4.7	5.7	2.4	7.4	5.3	1.9
	(3.6)	(3.5)	(3.7)	(3.9)	(4.1)	(3.2)

*Long-term means are given in parentheses. They are taken from records made over 22 years (1951–1973) at Morgantown by USDA and WVU (1982).

Appendix Table 2

Extra-Cost Items and Calculations for Creep Pastures.

Items	Calculation
Creep gate	$7.20 per gate on basis of cost of $72 per gate as purchased assuming a life of 10 years.
Creep pasture	*$80 per year including establishment and maintenance cost, assuming a 5-year period to replace the creep pasture.
Electric fence	**$.40 per foot + 11% maintenance per year of the initial cost, assuming a life of 25 years.
Extra woven fence	**$.55 per foot + 8% maintenance per year of the initial cost, assuming a life of 20 years.

*From G. Eagan. 1985. *West Virginia Field and Forage Crop Enterprise Budgets.* Coop. Ext. Ser. Publ. 802.

**From M. Rouhani-Iravan and R. Burton. 1984. *Fencing strategies for beef and sheep producers: a comparative cost analysis.* W.Va. Agr. & For. Expt. Sta. Bull. 688.

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867—4093