WORKING WITH MEADOW FOXTAIL: FERTILIZATION AND LIVESTOCK GRAZING

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Native flood meadows are an extremely important resource, both for livestock and wildlife. Over 3 million acres of native flood meadow exist in the western United States, with about 400,000 acres in Oregon. These lands produce a majority of the winter feed for cattle. Changes in botanical composition and yield can, therefore, have major implications for the livestock industry. In this paper I will review some of the work which has been completed on native meadows, and present recent results of research done at the Eastern Oregon Agricultural Research Center.

Native meadows of southeast Oregon developed over a long period of time into a complex mixture of rushes (Juncus spp.), sedges (Carex spp.), grasses, and forbs. Snowmelt from surrounding mountains provides an annual period of flooding which typically lasts from April to late June. Depth of flooding was found to influence yield and composition of these meadows (Rumburg and Sawyer 1965). Longer periods of irrigation increased yield except when surface water exceeded about eight inches. Areas with water depths exceeding eight inches were dominated by baltic rush (Juncus balticus).

Historically these native plants produced, on average, about 1.6 ton/acre (Rumburg 1961). Almost all of the production occurred during the short flooding period in spring. Regrowth production after haying or grazing was very low. Rumburg (1961) reviewed previous research conducted on meadows in southeast Oregon. Workers at this station have investigated the potential of using both fertilization and introduced plants to increase forage production and improve hay quality. They found that sedges and rushes responded very little to added nitrogen (N), and that with N fertilization, grass composition of the forage increased while sedges and rushes decreased. Based on this research, the recommendation given was to apply 60 lb N/acre in the spring only to meadows containing Nevada bluegrass and sedges. Areas which flooded deeper than 6 inches were not recommended for fertilization. Fertilization at the recommended rate yielded about ¾ ton/acre of additional forage. Source of nitrogen was not critical, and the general recommendation was to use the N source which gave the lowest cost per pound of nitrogen.

In an effort to increase quality and yield of meadow hay, Gomm (1980) planted several cultivars, including timothy (Phleum pratense L.), meadow foxtail (Alopecurus pratensis L., cultivar: P-5903), and creeping foxtail (A. arundinaceus, cultivar: Garrison). Reed canarygrass (Phalaris arundinacea L.) was another species which had already been introduced sometime prior to 1971, since Gomm (1978) reports using it in his work. Meadow foxtail was also introduced to the area from hay grown in other locations and purchased by local ranchers. Most foxtail introduced as hay was probably the common variety of A. pratensis. Since introduction of these species, meadow foxtail has greatly increased throughout the Harney basin and elsewhere in the region.

One of the attributes which makes

meadow foxtail an excellent grass for this region also works against the hay producer: foxtail starts to grow early in the spring as soon as soils begin to warm. Soon after it begins to grow stem elongation and floral development begin. This is a problem for hay producers in this area because the system of wild flooding used locally precludes any opportunity for early haying. As a result, meadow foxtail is often past the optimum stage of maturity when it is harvested, causing reduced protein and digestibility percentages.

Recent research at this location has shifted focus to investigate meadow foxtail management (Turner et al. 1984, Blount et al. 1991, Angell 1992, Angell et al. 1995). Meadow foxtail recovers quickly after grazing (Seamands, 1973) and will continue to grow as long as soil water is adequate. Grazing, therefore, may have considerable potential for improving management of native flood meadows containing meadow foxtail.

One viable alternative to harvesting a single crop of hay is using the forage as a grazing resource. Highly productive forage systems appear to be well adapted to intensive grazing management (Sharrow, 1983), so these southeast Oregon meadows may have significant potential for use as a grazing resource. Grazing could remove the flowering stems and stimulate development of vegetative tillers. Some type of rotational grazing system could be employed to maintain the forage in a less mature, leafier stage of growth.

Rotational grazing systems come in many varieties, but two which appear to have significant potential are short-duration grazing and strip grazing. The two systems have many similarities, and in both systems animals are confined to small portions of the pasture. Strip grazing, however, uses movable fence in place of permanent fencing. This allows greater flexibility in controlling both grazing area and grazing duration: as growth rate changes, the rancher can change both the size of the area being grazed, and the length of time it is grazed. Early on, research in Great Britain (Holmes et al. 1950, Waite et al. 1950) indicated that animal production per acre could be increased when strip sizes were sufficient to provide a one day supply of forage. In New Zealand, researchers found similar results using a system of two strips per day (Lucas and McMeekan 1959). Obviously, any system which requires daily or twice daily movement of fences can become too labor intensive unless technology can be employed which decreases management costs. We conducted a one year trial with strip grazing to see if a 5-day grazing period could be used.

METHODS

Study Site

Data presented here were obtained from studies conducted on meadows located at the Eastern Oregon Agricultural Research Center, Burns, Oregon (43° 31' N, 119° 02' W; elev. 4120 ft), about 5 miles south of Burns, OR. Mean annual precipitation (30 yr mean) is about 11 inches, primarily as winter snow. Soils have not been described, but are mainly Fluventic and Cumulic Haplaquolls. Generally, the profiles have low chromas, mottling, and dark surface horizons high in organic matter (Gomm 1979). Irrigation water is supplied by surface flooding.

Fertilizer Trial

In March of each year (1995-1997), 48 plots were fertilized with 0, 36, 72, or 108 lb N/acre, applied as urea, using a tractor-drawn fertilizer spreader. Plots were 15 x 30 feet in size, with a 3-ft wide buffer on all sides. Forage yield at each level of fertilizer was measured at three consecutive weekly intervals each year, beginning as soon as ground was dry enough for haying equipment. Initial harvest dates were 17 July 1995, 9 July 1996, and 10 July 1997, with two additional harvests following at weekly intervals. Each combination of fertilizer rate and harvest date was replicated four times.

On each harvest date, a swather was used to cut a 12-ft wide swath through the center of each plot. Immediately after swathing, a 20-ft long section from the center of the windrow was measured to obtain a fresh weight. A sample of the windrow was then placed in a bag, weighed, and taken to the lab for drying. All fresh weights were then converted to a dry matter basis, and reported as pounds or tons per acre. The dried sample was then ground and analyzed for crude protein and dry matter digestibility.

Strip Grazing Trial

In April 1989, meadow foxtail dominated flood meadow was fenced into 4 equal pastures of about 14 acres, with 2 pastures assigned either to continuous (CG) or strip (SG) grazing. Eighty yearling steers (556 lb) were stratified by weight into 4 groups and assigned to pastures. During the trial only 10 acres of each SG pasture were grazed; the remaining 4 acres were cut for hay. Steers on CG had access to the entire pasture at all times, while animals on SG treatments were restricted by portable electric fencing to a strip estimated to provide a 5-day supply of forage. Fences were moved to a new area on 5-7 day intervals, when forage utilization was visually estimated to be about 65%. Steer weight change was determined for each group by weighing after overnight restriction from feed and water. At weaning the previous fall, steers had received clostridial, infectious bovine rhinotracheitis, and bovine viral diarrhea vaccinations. Prior to placing animals on treatment all steers received zeranol, and received another clostridial vaccination. Insecticidal ear tags were applied, and animals were maintained on meadow vegetation for 4 weeks prior to study initiation.

Diet sampling was conducted approximately biweekly, starting on the second day of grazing in each strip. Collections were made in each pasture on two consecutive days. Esophageal fistulated steers were fasted overnight, and released to graze for 35-40 minutes. Dietary protein was determined by macro-Kjeldahl digestion and reported as crude protein (CP=N x 6.25). Digestible dry matter (IVDDM) was determined by 48 hr. *in vitro* digestion. Total fecal collections began the day following diet collections. Fecal bags were placed on the animals by 0700 and remained in place for 24 hrs. Upon removal, fecal bags were weighed and the dry matter of feces determined. Forage intake was then determined.

RESULTS

Fertilizer Trial

Meadow foxtail responded to nitrogen fertilization with significantly increased forage production in each of the three years studied (Fig. 1). In 1995, yield increased 700, 340, and 440 lbs/acre for 36, 72, and 108 lb N/acre fertilizer rates, respectively. In 1996, dry matter yield incremental increases were about 1000, 870, and 1175 lbs/acre for 36, 72, and 108 lbs/acre of N, respectively. In 1997, incremental increases at each level of fertilizer were similar to 1996. The first year of this study (1995) occurred at the end of a period when 4 out of the last 5 years were drier than average, and may have influenced plant response to nitrogen that year.

During the dry years preceding the study, no irrigation water was applied, and forage growth was severely limited, so less nitrogen was taken up by plants. In 1995, we observed lower incremental increases at 72 and 108 lb N/acre. This may indicate that soil nitrogen availability was above normal that year. One possible explanation for this is that during the previous drought years available soil nitrogen had increased through processes such as organic matter decomposition and atmospheric nitrogen deposition. These processes which increase available soil nitrogen were coupled with lower plant demand because of the drought years.

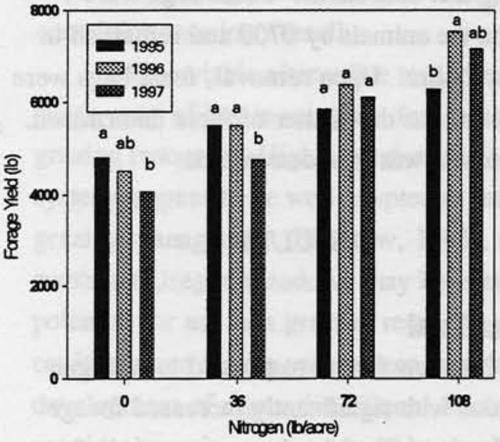

Figure I. Dry matter yield on an eastern Oregon flood meadow fertilized at four levels with urea. Fertilizer was applied in March of each year. Dry matter yields are averages of three consecutive weekly harvests in each of the three years. Within each level of N, bars covered by different letters differed at P=0.05.

The last 2 years of the study (1996 and 1997) also had excellent water availability and continued high levels of forage production. In these two wet years, the incremental increase in yield noted at each level of nitrogen was greater and remained fairly consistent. The largest single incremental increase in forage production occurred in 1977 for the 72-pound rate; over 1300 pounds of added forage were gained for the 36 additional pounds of N applied. The fairly linear increase for each level of N in both 1996 and 1997 indicates that nitrogen was probably more limiting than it was in 1995. Once again, this was probably a reflection of the dynamic interaction between climate and soil nitrogen. During wet years, more of the available N is taken up by plants, both in aboveground forage, and in below ground roots and storage organs.

One of our working hypotheses was that nitrogen fertilizer would be more beneficial during each succeeding year of a wet cycle. Two pieces of evidence seem to bear this out. With no fertilizer, yields declined (P=0.05) between 1995 and 1997. And, even at the 36 pound rate, the yield in 1997 was significantly less than in the first two years. The two highest rates maintained forage yield throughout the study. I interpret these data to show that nitrogen was becoming more limited with each successive wet year. Therefore, it appears that the most efficient way to apply nitrogen would be after a series of wet years. It should be applied in the spring, at the point where we know what our snowpack is and we can predict whether or not we will have a good water year.

Strip Grazing Trial

Dietary CP and IVDDM both declined significantly (P<0.05) over the summer (Table1), which is a typical result of advancing plant maturity. Decreases in forage quality were likely minimized in CG steer diets because herbage allowance was greater for them, which probably allowed them to select recent regrowth of higher quality. The SG steers did not have this advantage for two reasons. First, herbage allowance was maintained at much lower levels, and second, access to previously grazed areas was prevented. Between CG and SG treatments, seasonal means for CP tended to differ ($P=0.14$), at 13.9 and 10.9%, respectively.

Table 1. Crude protein (CP) and *in vitro* digestible dry matter (IVDDM) of steer diets on continuous or strip grazing systems.

	Continuous		Strip	
Date	**CP**	**IVDD**	**CP**	**IVDD**
May 1	18.7	76	17.2	74
May 2	16.4	70	13.7	69
Jun12	15.3	68	12.8	66
Jun26	13.9**	66**	9.4	57
July10	13.7*	65*	9.6	60
July24	12.8**	62**	8.6	53
Aug 7	12.2**	60**	7.5	52
Aug21	8.5	54	7.1	55
Sept 4	13.8	59	12.5	60

Asterisks (* or **) indicate grazing treatments differ at $P=0.05$ or 0.01, respectively.

Likewise, digestible DM was higher ($P=0.07$) in CG steer diets than SG ($P=0.07$), at 64.6% vs 60.7%, respectively.

Table 2. Dry matter (DM) intake (percent of body weight), average daily gain (ADG) and total gain per acre of steers under strip or continuous grazing of native flood meadows
May 1 - Sept 4, 1989

	Treatment		
Item	**Continuous**	**Strip**	**SEM^{c}**
DM Intake (%BW)	2.1%	2.0%	
ADG (lbs)	2.6^{a}	1.8^{b}	0.4
Gain per acre^{d}(lbs)	23.3^{a}	19.7^{a}	0.4

^{a,b} Means within rows differ ($P<0.10$) when followed by different letters.

^{c} Standard error of the mean.

^{d} Based on total seasonal grazed areas of 14 and 10 acres for continuous or strip treatments, respectively.

Daily forage intake was the same on both grazing systems ($P=0.42$), at 2.0 and 2.1% of body weight on SG and CG, respectively. Intake (lb DM/day) increased between May and September as a result of increased body mass and rumen capacity. Steers in the CG treatment tended ($P=0.09$) to perform better on an individual basis than SG steers (Table 2). Increased performance of steers on the continuous grazing treatment resulted, at least in part, from the higher-quality diets observed during mid-summer. However, even when diet quality was similar between treatments, ADG tended to be greater for animals on CG. This suggests that factors other than diet quality influenced gains. In this study, liveweight gain per acre did not differ between treatments, at 23 and 20 lb/ac for CG and SG, respectively.

Increased ADG on CG was offset by the smaller pasture area grazed under SG management (14 vs 10 acres, respectively).

CONCLUSIONS

Fertilizer Trial

Nitrogen fertilization significantly increases forage yield on eastern Oregon flood meadows. Based on this study, increases in yield are greatest when N is applied after one or more consecutive years of heavy runoff from mountain snow. The greatest incremental increase in forage yield occurred between the 36- and 72-pound rates in 1997, with about 1300 lb of increased yield. The greatest absolute increase in total yield with N fertilization occurred in the third year at the 108 lb N/acre rate, with about 1.5 tons/acre of increased forage yield compared to non-fertilized plots. Although we put on up to 108 lb N/acre, the fairly consistent increases seen at each level of N indicate that we did not reach the maximum yield potential of meadow foxtail.

Strip Grazing Trial

Strip grazing resulted in consistently lower herbage allowance compared to CG and apparently altered the ability of SG steers to select a diet equal in quality to the diet of CG steers, especially in July. Despite lower diet quality, forage intake of SG steers, as a percentage of body weight, was similar to that of CG steers. Individual animal performance tended to be greater for CG steers throughout the study. However, total animal gain per acre was similar between management systems because pasture area utilized by SG steers during the study was less than for the CG treatment. The greatest impact on individual animal performance on the strip grazed units was probably related to the length of the rotation period. However animals on SG tended to gain at a slower rate even in May and June when diet quality was similar between treatments. Late in the summer diet quality for SG animals increased because animals were grazing high quality regrowth. This study demonstrated that native flood meadow vegetation containing meadow foxtail can produce excellent animal performance, and that strip grazing will provide similar animal gain/ha while reducing the total land area required. Further research investigating both different stocking densities and various grazing intervals is needed. These would help determine the factors other than diet which influence animal performance.

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