



University of California Cooperative Extension

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January 14, 1998

Gary Markegard, Farm Advisor
UC Cooperative Extension
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Gary:

I have enclosed two documents: one is the report from work at the Klamath Experiment Station by Randy Dovel (Klamath Falls), the second is a proposal that Steve and I submitted for grant funding. It was not approved. Hopefully this will give you some idea of what others have done or are doing. We are starting this spring.

One of the practical matters is scheduling trial harvest. We will set up a schedule for the most frequent cutting rate (2 weeks for us). Then the other harvests will occur at the same times but less often. For example, the 4 week interval plots will get harvested every other time. You might want to consider your intervals with this in mind.

For us, the most convenient plot map would consist of 6 plots per block (replication) thus 6 treatments: 3 cutting schedules each at 2 heights.

5	4	1	3	6	2	3	6	1	5	4	2
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The first six treatments would be the first block (rep) each treatment randomly assigned. The second six treatments would be the second block. The treatments we will use are shown below and I just made up a schedule for your dates (couldn't remember your figures). You would not have different harvest heights.

Treatment No.	Our trial	Your Trial?
1	2 weeks, 4 inches	15 days
2	2 weeks, 2 inches	30 days
3	4 weeks, 2 inches	45
4	4 weeks, 4 inches	60
5	46 days, 2 inches	120 days
6	46 days, 4 inches	180 days

A key question is what are you trying to answer. From our discussion it sounded like "how does cutting schedule effect forage at specific dates, and total. We might hypothesize that one schedule will produce more forage but of a lesser quality. Which schedule produces the most TDN or protein per acre? is another question that could be

answered with the same data. Growers could use the data to decide the best schedule for them.

I hope this helps. Let me know if it is unclear, and I would be glad to see your next step. I think your work might fit in with some of the other but for a different species and different conditions. That would be interesting and helpful.

We've been getting a lot of rain, assume you are very wet. Probably too wet to get much done outside right now. I was glad to see you attend the workgroup meeting. Guess you guys are going to get something together on the Coast for Natural Resources. I've really enjoyed and benefited from the IM workgroup.

A handwritten signature in black ink, appearing to be the name 'Dan' with a stylized flourish.

Take care, Dan

Enclosures

RESEARCH PROJECT PROPOSAL

Effects of harvest schedule and cutting height on pasture quality using NIR and wet chemistry

INVESTIGATOR(S): Dan Drake, Steve Orloff, Farm Advisors, Siskiyou County and Randy Dovel, Oregon State University, Ag. Exp. Station, Klamath Falls, OR

RESEARCH PROBLEM:

Harvest schedule (cutting frequency and rest period) and cutting height affect plant quality. However, the effect of these parameters is not well understood for pasture. Near infra-red analysis offers potential for rapid, inexpensive forage analysis. This project is a field trial to evaluate the effect of harvest schedule and cutting height. Both NIR and wet chemistry will be used to evaluate the effect of these parameters on forage quality. The usefulness of NIR analysis will be studied.

DESCRIPTION:

Pasture is a large use of natural resources in northern California and efficient use is important. Harvest schedules influence the amount of rest and recovery plants receive between cutting (or grazing). Similarly, cutting height influences plant re-growth potential. Both of these factors interact over the growing season to influence yield and quality. Wet chemistry is the acceptable standard for determination of forage quality. However, NIR analysis offers potential rapid and inexpensive chemical analysis. Paired samples will be used to develop appropriate regression equations between wet chemistry and NIR and enable a comparison NIRs usefulness.

RESEARCH NEEDS:

A factorial design using harvest schedules of 2, 4 and 8 weeks, with cutting heights of 2 or 4 inches will be used with four replications at a cooperating ranchers established irrigated pasture. This will generate 108 samples for wet chemistry determination of ~~NDF~~ ADF, and crude protein. This is a total of 324 wet chemistry values. Similar analysis will be determined at Oregon State University using NIR. Samples will be milled by Orloff and Drake and submitted to each lab in ground form..

FUNDING STATUS:

This project is currently unfunded. A proposal has been submitted to UC SAREP program for financial assistance in establishing the field plots, collecting and preparing samples. This work would contribute to long-term projects of the Intermountain Workgroup for intensive grazing strategies, efficiency of water use and sustainable production.

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Pastures occupy over 250,000 acres in the five county Intermountain (IM) area of California (40 percent of which are in Siskiyou County). They are vital to the area's 100 million dollar livestock industry. Pasture has historically been devoted to low-quality lands unsuitable for other crops. They have been a low priority for academic research and private management. Pasture is a major resource under private management and is important to local economies. Pasture production requires large amounts. With greater demands on open spaces, water conservation, reductions in timber production, decreases in public lands grazing, and depressed local economies the role of irrigated pastures is keystone to agricultural, resource and social sectors. Pastures will become even more important for cattle production if or when public lands grazing sufficiently decreases. Failure to adopt improved pasture production would likely result in reduced herd size, reduced net income and business loss. These reductions would impact social and lifestyle factors in livestock-based rural areas. Thus, increased knowledge of location-specific impacts of grazing or haying practices on pasture resources are important for long-term economic, resource and social stability.

Pasture is used for both hay production and grazing. Research has primarily been done on grass and clover varieties for yield under fixed hay cutting conditions. Grazing management recommendations are currently based on data from New Zealand or non-replicated case studies of grazing demonstrations. Systematic evaluation of pasture yield and quality under different grazing management for Northern California conditions has not been undertaken. Hay yield and quality compared to production under simulated grazing practices has had limited evaluation. This work suggests great differences between cutting frequency which mimic haying (cutting at 4 inches and 28 days) compared to grazing (cutting at 2 inches and 14 days). Work at the Sierra field station, not in the IM region, suggested a height of 4 to 6 inches across the season provided the best pastures. New Zealand recommendations for perennial ryegrass are to harvest leaving a residual of no less than 1,000 kg DM/ha. This has been related to 2 to 4 inches of pasture. However, this recommendation was developed for perennial rye not tall fescue.

Extension demonstrations have led to increased adoption of controlled grazing permitting more precise harvest of pasture and increased pasture productivity. However, most of these recommendations are based on observations. This work would simulate grazing and provide direct comparisons of harvest height and interval on yield and quality of pasture.

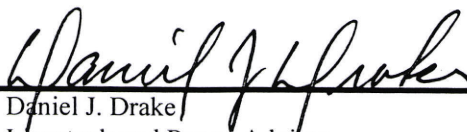
For this project, we are planning to use an existing pasture of tall fescue and clover, the predominant pasture type in the IM area. It will be irrigated and fertilized by the cooperating rancher. Cattle will graze the pasture in areas not involved in the replicated trial. The trial will involve machine harvest of plots evaluating yield and quality by cutting (harvest) height and interval between harvest (rest). Cutting heights of 2 and 4 inches and rest intervals of 2, 4 and 8 weeks in a factorial design will permit statistical analysis of all possible combinations of cutting height and rest. In addition, growth rates by periods can also be calculated and statistically evaluated.

Specific evaluation will be made to determine: 1.) yield, 2.) quality (crude protein, and total digestible nutrients), and 3.) nutrients produced per land unit (product of yield and quality) for each harvest height and interval.

Yield will be determined from whole plot sampling. Quality will be obtained from subsamples. Quality analysis will be from ground samples using NIR and wet chemistry.

Requests are for 108 samples with determination of ADF, ~~NDF~~ and crude protein (kjeldahl nitrogen) for each sample.

Additional support has been requested from the UC SAREP program. This is for establishment of the field plots, support of harvest and collection of samples, and preparation of samples for analysis. In addition, financial assistance would be provided to disseminate results.

 9/26/97

Daniel J. Drake
Livestock and Range Advisor

 9/26/97

Steve B. Orloff
Crops Farm Advisor

KLAMATH EXPERIMENT STATION



OREGON STATE UNIVERSITY

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Memorandum

DATE: April 9, 1997
TO: Don Lancaster
RE: Forage Research
CC:

Hi Don,

I've changed the report so much that I'm sending a new one. It is part of the station annual report. This is a first draft. I welcome your comments.

Randy Dovel

Pasture and Hay Grass Variety Trial

R.L. Dovel and J. Rainey¹

Introduction

Several grass hay variety trials were established at Klamath Experiment Station in 1988. Since that time new varieties have been developed and should be tested in this area. In addition, there is a need to test pasture grasses under a management system that more accurately reflects controlled grazing and not a three cutting hay schedule. A trial was established to test forage production and stand persistence of pasture grasses in the Klamath Basin under both haying and simulated grazing management. Entries included released and soon to be released varieties of tall fescue, orchardgrass, perennial ryegrass, and Bromus species.

Procedures

The trial was planted in the fall of 1995 at KES. Plots were arranged in a randomized split plot design with 3 replications. Clipping management was the main plot and variety was the split plot. Seed was sown using a cone seeder in 6-inch rows. Seeding rate was as recommended for each species. Seeding rate is detailed in table 1. Planting depth was 0.25 inches. Plots were 5 x 20 feet with 3-foot wide alleyways.

Prior to seeding, fertilizer was applied and incorporated as indicated by soil tests. 75 lb N/ac was applied at planting. Following establishment, 50 lb N/ac was applied in mid-March, mid-June, and mid-July. Plots were irrigated by solid-set sprinkler irrigation. Evapotranspiration was determined from a weather station on site and weekly applications were made accordingly.

Plots were allowed to grow unclipped in the establishment year. Plots managed as a hay trial were cut when 50 percent of the entries were heading. Cutting height in these plots was 2 inches. Plots being managed as simulated grazed plots were cut when 50 percent of the entries reached 10 inches or more in height. Simulated grazing plots were cut to a 4-inch cutting height. Plots were clipped using a Carter flail plot harvester. Measurements will be taken for three full production years. Winter survival will be determined for three winter periods.

All yields are reported on a dry weight basis. Forage quality, as determined by crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV), was evaluated from samples obtained at all harvests.

^{1/} Associate Professor, and Research Technician, respectively, Klamath Experiment Station, Klamath Falls, OR.

Acknowledgments: Partial support for this trial has been provided by a number of seed companies, whose varieties are represented here. The Experiment Station greatly appreciates their support and participation.

Results

Yield

Clipping management was the most significant factor affecting forage yield. Simulated grazing produced only 53 percent as much dry matter as hay management (Table 1). Frequent clipping reduces photosynthetic surface area and thus reduces growth. The longer clipping interval of the hay clipping treatment allowed a much larger photosynthetic area to produce growth.

Matua was the highest yielding entry under both hay and simulated grazing management. The next three highest yielding entries under hay management were tall fescue entries, ISI-9077, ISI-8872, and AU Triumph. Kemal, a *Festulolium*, was not significantly lower yielding than the three highest yielding tall fescues. Average tall fescue yield under hay management was significantly higher than either orchardgrass or perennial ryegrass.

Forage yield of some entries was less affected by clipping management. Under simulated grazing, two entries, AU Triumph and Latar, produced 60 percent as much dry matter as under hay clipping management. In contrast, BG3 and Cambria produced 43 percent as much dry matter under simulated grazing as under hay clipping management. In general, orchardgrass was less affected by clipping management than tall fescue and perennial ryegrass, 55 percent compared to 50 percent. However, variability within species was very high.

Forage Quality

As was seen in forage yield, clipping management was the most significant factor affecting forage quality, both protein and TDN. Average protein and TDN were 16.8 and 59.0 under clipping management compared to 22.2 and 64.2 under simulated grazing. All entries had high forage quality, with minimum values of 14.1 percent protein and 53.6 percent TDN, under hay management. Matua produced the lowest protein concentration and Gala the lowest TDN value under grazing. The low protein value of Matua is due to high biomass

production. Nitrogen uptake and assimilation did not keep pace with the rate of forage production. Gala TDN values are probably low due to low genetic potential. It was not selected for high forage quality and has been criticized by other researchers for low digestibility.

Average forage TDN values for tall fescue were higher than for perennial ryegrass and similar to orchardgrass under both hay and simulated grazing management. This was unexpected. Perennial ryegrass is reputed to have higher forage quality than other cool-season pasture grasses and tall fescue is thought to have lower forage quality than either orchardgrass or perennial ryegrass. Under hay management, lower perennial ryegrass TDN values may be explained by different maturity levels of the species involved. Perennial ryegrass tends to be earlier maturing than later maturing orchardgrass and tall fescue varieties included in this trial. However, clipping frequency under simulated grazing management was approximately two weeks and differences in maturity would be negligible.

Average forage protein concentration of orchardgrass and tall fescue was similar and significantly better than perennial ryegrass, under hay management. It may be that fertilization and irrigation management moved N below the effective rooting depth of perennial ryegrass but was still accessible to the deeper rooted species. Under grazing management, orchardgrass had slightly higher protein levels than perennial ryegrass and tall fescue, which were not different from each other.

There was also considerable variability in forage quality within species. The most notable example of this is Barcel tall fescue, which has been selected for high quality. It had an average TDN of 60.1 and 66.7 under hay and simulated grazing clipping management, respectively.

Nutritional Yield

Nutritional yield is the product of forage yield and nutrient concentration. It is useful in determining expected animal production and performance. Protein and TDN

yield were less affected by clipping management than forage yield. Although frequent clipping reduced forage yield by 46 percent, it only reduced protein and TDN yield by 30 and 42 percent, respectively, because of higher forage quality in frequently clipped plots. Rankings of total nutrient production closely resemble those of forage production because the relative differences in forage quality between entries were less than relative differences in forage yield.

Seasonal Trends

Because the clipping frequency of the simulated grazing treatment was approximately every two weeks, seasonal trends in forage growth and quality can be examined. Growth rate is calculated by dividing the dry matter produced by the number of days in the growth period. Growth rate was initially slow in the spring due to cool temperatures (Figure 1). It rose to maximum levels by late June and remained high through mid July before dropping to half the maximum level during late July and early August. This was due to temperatures exceeding optimal levels for cool-season grass growth in late summer. As temperatures cooled in late August, growth rates recovered to former levels. Growth rates declined in late September as temperatures cooled.

Cool-season grass growth responses to temperature may be examined by comparing growth rates during a growth period to the average temperature during that period. The relationship of growth rate and temperature can be determined using regression analysis. This relationship is depicted in Figure 2. Growth rate approached zero as temperatures dropped below 52°F and rose until reaching an optimal temperature of about 63 °F. As average

temperatures rose above 63 °F, growth rates declined. Using this correlation it is easy to understand the phenomena known as the summer slump, when cool-season grass growth declines even when moisture is not limiting.

Forage quality also varied across the season. Protein concentration of simulated grazed plots varied widely from cutting to cutting. Initially there appeared to be no pattern (Figure 3); however, N fertilization dates must also be considered. Plots were fertilized immediately after each hay cutting, which are depicted in Figure 3 as light squares. Immediately after fertilization forage protein concentration rose and then declined steadily until fertilizer was applied again. Multiple N applications will result in more uniform protein levels throughout the season than a single large application in the spring.

Seasonal trends were also seen in TDN levels and were largely correlated with temperature and not N fertilization (Figure 4). TDN levels declined as temperatures increased in the spring until reaching a low in early August. They then returned to the high levels seen in the spring as temperatures cooled in the fall.

TDN was highly correlated with temperature. A simple linear relationship adequately described the effect of temperature on TDN. Regression equations were developed for most of the entries in the trial and are depicted in Figure 5. There is little difference in the slope of the lines, which indicates that the entries respond similarly to temperature. There is a large group of entries in the middle with little difference between them and two clearly distinct entries. The entry with high TDN is Barcel and the low TDN entry is Matua. This is similar to the tabular data using season long averages in Table 2.

Table 1. Total Forage Yield. Effect of clipping management on forage yield of cool-season grasses in 1996. Values represent totals from three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

Variety	Species ¹	HAY			GRAZING			Percent of
		Yield			Yield			Hay Yield
		lb/A	ton/A	rank	lb/A	ton/A	rank	%
Gala	BS	13,930	7.0	7	8,280	4.1	3	59
Matua	BW	19,450	9.7	1	11,480	5.7	1	59
Kemal	FES	14,880	7.4	5	6,570	3.3	8	44
BAR 051	OG	10,720	5.4	21	6,470	3.2	13	60
BAR 5USF	OG	10,990	5.5	16	5,370	2.7	21	49
Bronc	OG	10,950	5.5	18	6,440	3.2	12	59
Cambria	OG	10,470	5.2	23	4,490	2.2	23	43
Comet	OG	11,240	5.6	15	6,040	3.0	18	54
Latar	OG	10,570	5.3	22	6,310	3.2	11	60
Lupre	OG	11,640	5.8	13	6,580	3.3	9	57
Pizza	OG	10,880	5.4	19	6,080	3.0	16	56
Potomac	OG	10,790	5.4	20	6,190	3.1	14	57
Tekapo	OG	11,290	5.6	14	5,920	3.0	19	52
Mean OG		10,954	5.5		5,989	3.0		55
BG3	PRG	11,630	5.8	12	5,040	2.5	22	43
Moy	PRG	10,960	5.5	17	6,010	3.0	17	55
Zero-nui	PRG	11,660	5.8	11	6,060	3.0	15	52
Mean PRG		11,417	5.7		5,703	2.8		50
AU Triumph	TF	15,110	7.6	4	9,080	4.5	2	60
Barcel	TF	12,370	6.2	10	5,400	2.7	20	44
Desperado	TF	13,820	6.9	9	6,630	3.3	10	48
Dovey	TF	13,820	6.9	8	7,620	3.8	5	55
Fawn	TF	14,190	7.1	6	6,670	3.3	7	47
ISI-8872	TF	15,230	7.6	3	8,060	4.0	4	53
ISI-9077	TF	15,320	7.7	2	6,880	3.4	6	45
Mean TF		14,266	7.1		7,191	3.6		50
Mean		12,520	6.3		6,681	3		53
LSD (0.05)		570	.3		180	.1		
CV (%)		14	14		38	38.0		

¹BS=Bromus stamineus, BW=Bromus willdenowii, FES=Festulolium(a meadow fescue x ryegrass hybrid), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

²Values represent the change in yield due to clipping management. Values represent Hay Yield / Grazed Yield * 100.

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Enclosed is the material which you have requested or which might be of special interest to you.

Mike :

Thanks for the tour
yesterday! You have a
nice piece of land!
I'm enclosing the material

9/5/97

Rollie Meyer

1. check on CaCO_3

method -

checking with lab on this

2. $1/2$ meter by $1/2$ meter (saw pits)

4 per treatment

$5/16$ " rod
(could get by with less ($1/4$ or $1/8$))

3. 24 or more plots for
a scientific journal

4. Adv. - look in statistic
book

1400 freedom ~~to~~ (70 either way)

5. 2 or 3 yrs needed on line
and plot

Table 2. Average Forage Quality. Effect of clipping management on forage quality of cool-season grasses in 1996. Values represent averages of three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

		Hay	Grazed	Hay	Grazed
Species ¹		-----Protein-----		-----TDN-----	
----- % -----					
Gala	BS	16.0	22.7	53.6	60.6
Matua	BW	14.1	21.7	54.1	61.3
Kemal	FES	16.1	21.6	56.6	63.5
BAR 051	OG	16.2	22.2	56.7	63.2
BAR 5USF	OG	16.1	22.7	57.8	65.0
Bronc	OG	16.5	22.7	58.3	64.6
Cambria	OG	17.4	23.0	58.5	65.5
Comet	OG	17.2	22.8	59.2	64.9
Latar	OG	16.5	23.0	58.2	64.3
Lupre	OG	16.2	23.1	56.8	64.8
Pizza	OG	16.5	23.5	58.3	64.9
Potomac	OG	16.5	23.0	57.2	65.2
Tekapo	OG	16.8	22.4	56.9	63.7
Mean OG		16.6	22.8	57.8	64.6
BG3	PRG	16.1	22.4	58.9	65.0
Moy	PRG	15.7	20.9	56.4	62.9
Zero-nui	PRG	14.9	21.4	55.5	62.7
Mean PRG		15.6	21.6	56.9	63.5
AU Triumph	TF	17.4	22.1	60.3	64.4
Barcel	TF	17.7	22.7	60.1	66.7
Desperado	TF	16.3	21.8	58.1	65.1
Dovey	TF	15.9	20.8	57.7	62.6
Fawn	TF	16.3	21.9	58.7	64.7
ISI-8872	TF	15.9	21.4	57.4	64.7
ISI-9077	TF	16.8	20.8	58.5	63.8
Mean TF		16.8	21.8	59.0	64.9
Mean		16.4	22.2	57.7	64.2
LSD (0.05)		0.9	0.7	1.3	0.8
CV (%)		6.2	5.3	2.5	2.2

¹BS=*Bromus stamineus*, BW=*B. willdenowii*, FES=*Festulium* (meadow fescue x annual ryegrass), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

Table 3. Nutritional Yield. Effect of clipping management on production of nutrients, protein and TDN, of cool-season grasses in 1996. Values represent production of three and eight harvests for hay and simulated grazing, respectively. Plots were established at Klamath Experiment Station on August 21, 1995.

Variety	Species	Hay	Grazed	Hay	Grazed
		-----Protein-----		-----TDN-----	
-----lb/A-----					
Gala	BS	2109	1735	7413	5001
Matua	BS	2631	2242	10479	7163
Kemal	FES	2282	1321	8310	4223
BAR 051	OG	1701	1367	6051	4110
BAR 5USF	OG	1754	1194	6354	3487
Bronc	OG	1791	1415	6378	4165
Cambria	OG	1817	1023	6132	2924
Comet	OG	1930	1325	6663	3915
Latar	OG	1731	1390	6147	4082
Lupre	OG	1868	1492	6585	4256
Pizza	OG	1785	1355	6351	3944
Potomac	OG	1763	1371	6174	4033
Tekapo	OG	1884	1298	6417	3789
Mean OG		1802	1323	6325	3871
BG3	PRG	1838	1094	6810	3278
Moy	PRG	1687	1203	6213	3804
Zero-nui	PRG	1708	1243	6468	3822
Mean PRG		1744	1180	6497	3634
AU Triumph	TF	2640	1956	9081	5867
Barcel	TF	2179	1202	7431	3587
Desperado	TF	2232	1431	8010	4322
Dovey	TF	2198	1554	7986	4797
Fawn	TF	2277	1388	8298	4326
ISI-8872	TF	2395	1706	8748	5170
ISI-9077	TF	2512	1373	8946	4386
Mean TF		2348	1516	8357	4636
Mean		2031	1421	7280	4280
LSD (0.05)		329	315	1026	912
CV (%)		17.6	39.7	15.3	38.2

¹BS=Bromus stamineus, BW=Bromus willdenowii, FES=Festulolium (a meadow fescue x annual ryegrass hybrid), OG=orchardgrass, PRG=perennial ryegrass, and TF=tall fescue.

Figure 1. Growth Rate of Cool-Season Grasses Under a Simulated Grazing Management System.

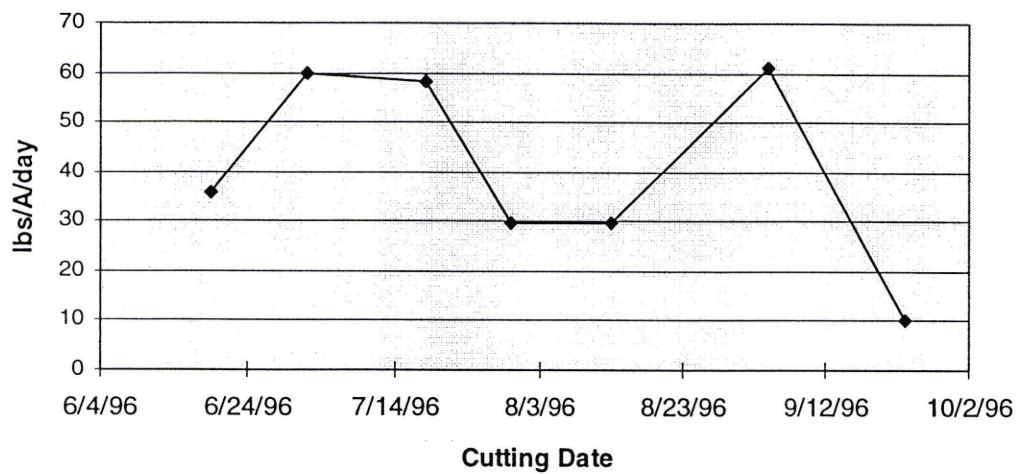
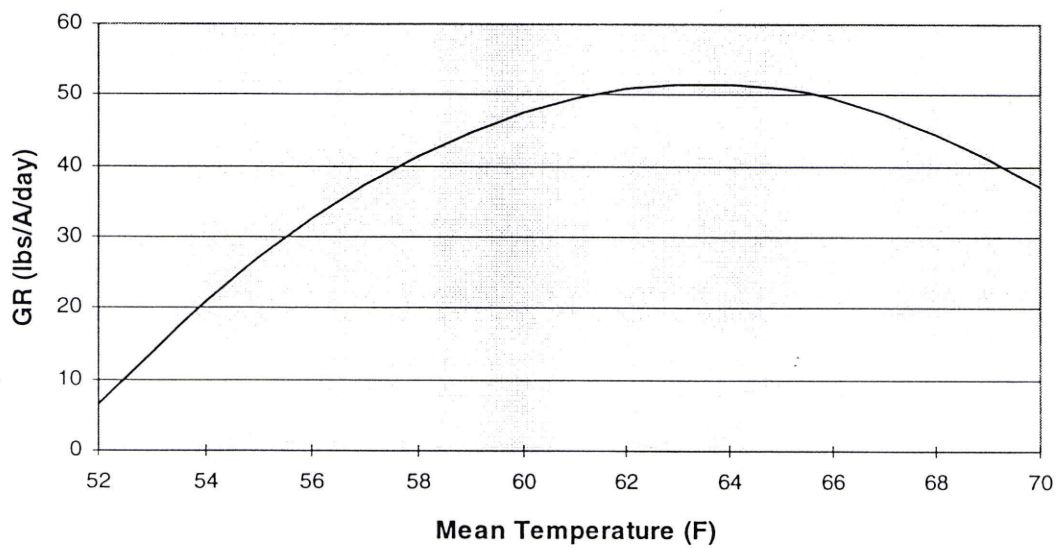


Figure 2. Effect of Mean Temperature on Growth Rate of Cool-Season Grasses Under Simulated Grazing.



Talked to Larry Forero 9/5/97

1. he has a formula for how many samples to take - it is based on statistical analysis - (dealing with how uniform area is) standard deviation, coefficient of variation
2. Larry liked Rollie Meyer's use of lawn mower for plots, but I would need to check with him on use for scientific papers
3. The reference persons he suggested were Steve Orloff, Barbara Reed,
4. David Lile was doing a similar project on mountain meadows working with Ken Tate
5. Larry thought I could pursue what I had in mind and submit it to rangelands with no problem

Figure 3. Protein of Forage Clipped Under Hay or Simulated Grazing Management Systems.

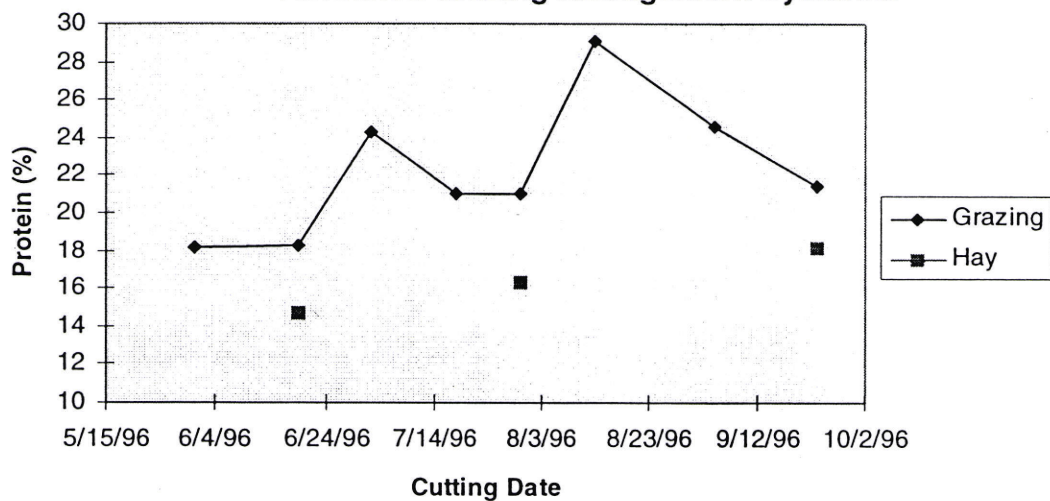


Figure 4. TDN of Forage Clipped Under Hay or Simulated Grazing Management Systems.

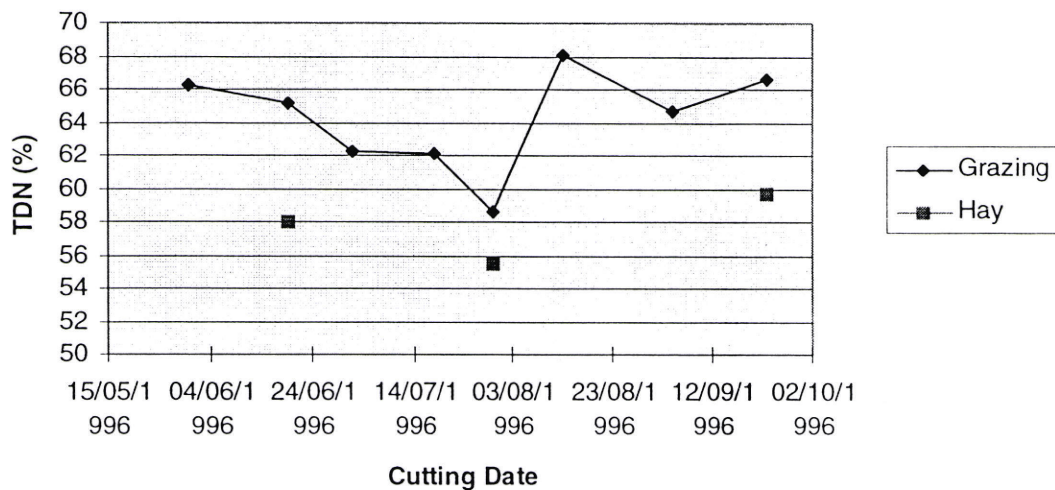


Figure 5. Effect of Mean Temperature on TDN of Cool-Season Grasses Under Simulated Grazing Management.

