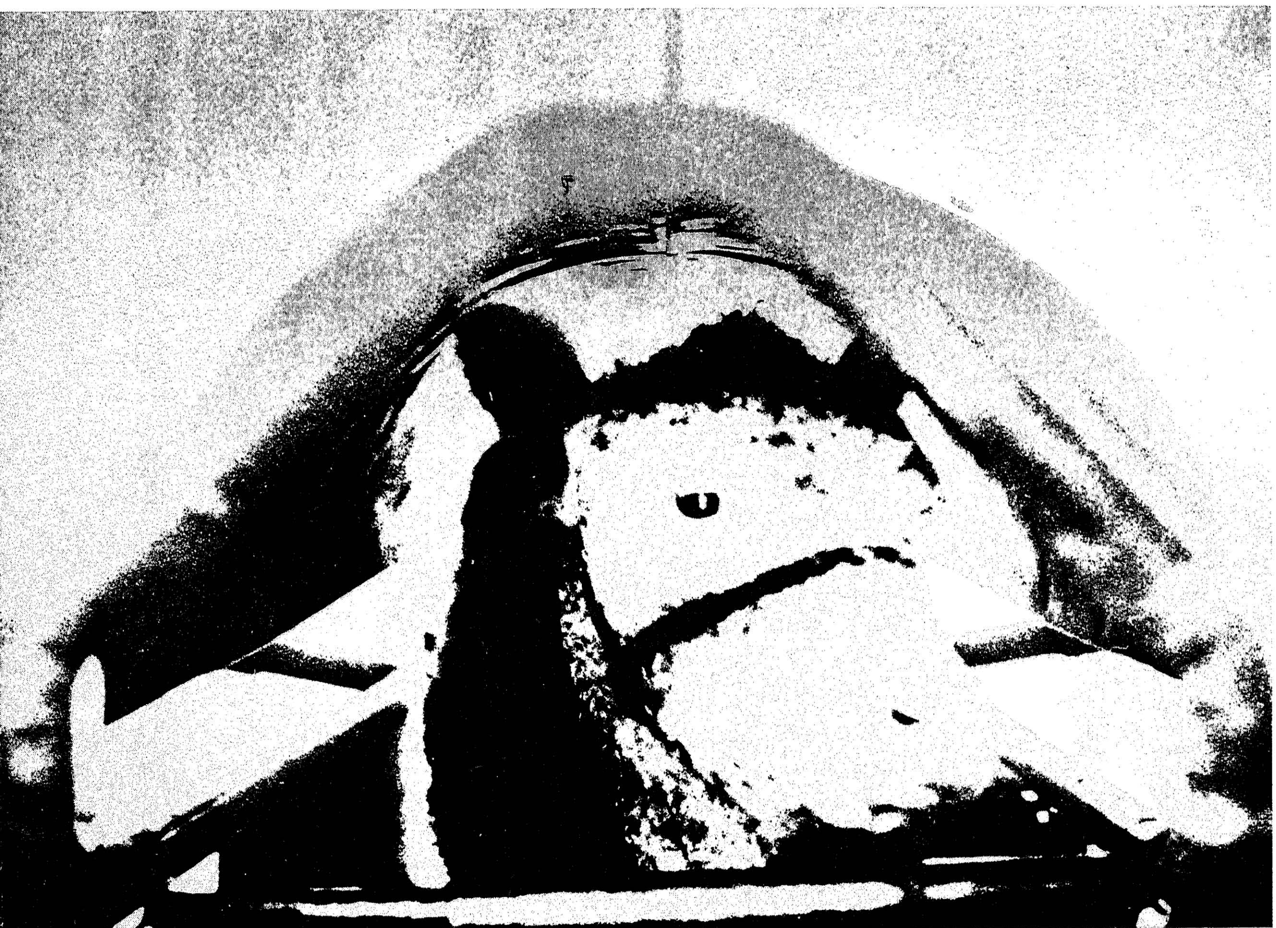
1977 FIELD DAY RESEARCH REPORTS

FORAGE SYSTEMS RESEARCH CENTER

Cornett Farm,

Linneus, Missouri



College of Agriculture,

University of Missouri-Columbia

SR 207

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Cover Photo: "Posterized" photo of calf in whole body counter. Picture by Jim Stricker.

Cost-Return Comparisons of Nitrogen Fertilization Of Tall Fescue Hay and Pasture

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The profitability of nitrogen-fertilization of grasses and grass-legume mixtures has been--and likely will continue to be--a vigorously debated issue. Highly variable prices for cattle, hay and fertilizer are only part of the reason for this ambiguity. A more important reason lies in the great variance in the yield responses observed.

In addition to a wide variation in nitrogen recovery rates and losses (from leaching, de-nitrification and direct volatilization), nitrogen yield responses can vary greatly for other reasons somewhat distinctive to forages. One pound of nitrogen actually recovered in plant growth could be fabricated (by the plant) into 100 pounds of additional D.M. (dry matter), if of only 6.25 per cent crude protein (1.0 per cent N)--or only 33 pounds of additional D.M.--if it is 18.75 per cent protein (3 per cent N). Or, this 1.0 pound of actually recovered N could be associated with <u>no</u> additional dry matter yield--serving instead to increase the per cent protein (and per cent N) of the existing DM yield.

A further reason for highly varied nitrogen responses is variation in the legume content of the stand--whether seeded or volunteer. When a good stand of a highly productive legume (i.e., alfalfa) is contained in the grass stand to be fertilized, there may be no yield response whatever to applied N. The applied N simply substitutes for the N the legume would otherwise have fixed from atmospheric nitrogen. With more modest legume stands, or with legumes of lesser productive potential (i.e., lespedeza)"modest" yield responses are more commonly observed--which may or may not be economical. Typical results were observed in 1971 in a renovation study on a tall fescue sward at Columbia. A spring application of 60 pounds N on tall fescue alone produced a 1596 pound (140 per cent) increase in dry forage, (or 26.6 pounds per pound of N). Where the same 60 pound application was applied to fescue renovated with legumes (red clovers, birdsfoot trefoil and lespedeza), the yield responses ranged from only 481 to 755 pounds per acre (16 to 23 per cent increases), and the yield response per pound of applied N varied from only 8.0 to 12.6 pounds additional dry forage. Further, the fescue renovated with legumes yielded more <u>without</u> N-fertilizer than the fescue alone did <u>with</u> 60 pounds N.

For all these reasons of varied losses and recovery rates, varied forage protein and N-percentages or maturities, and varied legume components in the stand, responses to applied N are highly variable between years, sites, experiments and systems of utilization or harvest.

<u>N-Responses Observed at the FSRC</u>

Variability in N-response has also been evident in research conducted at this station. Four years of year-round research have been completed with both the spring-calving and fall-calving herds. Average carrying capacity per acre by nitrogen treatments in AUM's (animal unit months--feed for one 1000 pound animal for one month) has been as follows:

Management System	NITROGEN TREATMENT N_1(0# N/A)	N_2(100# N/A)	N_3(200# N/A)
Spring Calvers (4 yrs.)	6.2 AUM/A	7.6 AUM/A	8.6 AUM/A
Fall Calvers (4 yrs.)	4.1 " "	5.5 " "	6.3 " "

As can be observed in the above data, the first 100 pounds N/A (N_2 vs N_1) produced an additional 1.4 AUM's of carrying capacity per area on the acres used for either the fall or spring-calving herds. A response of this magnitude suggests that 100 pounds N would have to be applied to around 10 acres to produce the additional forage required to support one additional cow and calf. At a 20 cents per pound cost for the N, the cost per additional cow year would be around $200.

Per acre yield response to the second 100 pounds N/acre (N_3 vs. N_2) varied from an additional 0.8 AUM (fall calving pasture) to 1.0 AUM (spring calving pastures). Responses of these magnitudes suggest that this added application would have to have been applied to 14-16 acres to produce added feed for an added cow. Again, at a 20 cent per pound N cost, the cost per added cow at this level of fertilization would approximate $280 to $320.

Responses in this year-round systems research could well have been more modest because of the management system employed. Spring growth in the winter pastures was baled as small round bales and left in the field for winter use. Electric fence was used to divide these pastures with bales and stockpiled fall growth into thirds to reduce waste. However, such a low labor system still insures more waste and deterioration than where bales are stored under roof and limit-fed during the winter to control both waste and consumption.

Where more labor or expense is used to reduce waste, it may be more useful to look at yields by periods and phases.

Looking only at the pasture yields from spring growth and the spring-applied portion of the fertilizer for 3 years (1975-77) on the fall calving herd, the average AUM's per acre already utilized by around the first of August were 4.18, 6.17, and 7.25 AUM's per acre for the N_1, N_2, and N_3 treatments respectively. Because only 60 pounds of each 100 pounds of N were spring applied, nearly all the nearly 2 AUM's difference between N_2 and N_1 was a result of the 60 pound spring application. At 20 cents per pound of applied N, a \$12 per acre application appeared to produce two AUM's of additional forage for a cost of only \$6 per AUM. The second 60 pounds N (N_3 vs. N_2) was only about half as productive--resulting in nearly twice as expensive an addition to carrying capacity. Similar data for the last year of the spring-calving research (spring of '75) was quite similar. Thus, additional carrying capacity produced in the spring appears to cost less--but of course is worth less in such a normally surplus period.

One-third of each summer pasture was reserved to produce hay each spring. Three year results on the summer pastures for the calving herd ('75-'77) on the N_2 pastures produced a dry matter yield of 2975 pounds per acre--or 1454 pounds more than the 1520 pounds produced with the N_1 treatment. At a 20 cent N-price, this \$12 per acre treatment produced additional standing dry matter at a cost of 0.825 cent pound or \$16.50 per ton. If half were given to get it harvested, the producer would have received additional hay at a \$33 cost per ton of DM--or perhaps \$27 per ton of 85 per cent DM hay.

Or, if a custom cost of \$25 per ton were paid to mow, rake, bale and haul to storage, the cost of additional 85 per cent DM hay would have been \$39 per ton.

A second increment of 60 pounds spring applied N (N_3 vs. N_2) produced only an additional 681 pounds DM per acre. If half were given to pay harvest, the cost per added ton of 85 per cent DM hay would have been nearly \$60. If, instead, the hay had been custom harvested for \$25 per ton, the cost per added ton would have been nearly \$55.

Similar data on the hayed one-third of summer pastures are available for the last year (1975) for the spring calving system. In contrast with the 3 year results in the fall calving pastures, the yield was much higher with zero N (N_1), and the DM response to the first 60 pounds N (N_2) was accordingly much smaller--or only 689 pounds per acre. The cost per added ton of 85 per cent DM hay would have been \$59 (if half given for harvest)--or \$54.60 (if \$25/ton paid for harvesting). A small DM response (192.5 pound) was received for the second 60 pound increment of N--yielding cost estimates of \$212 and \$131 per ton of 85 per cent DM hay respectively where harvest costs are half the hay or \$25 per ton.

These latter results are from only one year, but do represent four separate fields for each nitrogen treatment. They do also serve to demonstrate the extreme variability of yield responses even at a single location (FSRC) with similar managements, soil types, etc.

Nitrogen response and the profitability of its use on forages continue to pose difficult predictive questions. Direct transferences of experimental results and their apparent costs and return ratios to farms with different soils, managements, legume percentages, etc. remain difficult and hazardous. The largest and most economical responses should be expected on good stands of potentially high yielding grasses limited primarily by a soil nitrogen deficiency. Lowered yield potentials via drouth, shallow soils, poor stands, lower yielding species,--or high nitrogen adequacies via legumes--all tend toward lower and less economical responses to applied N.

Fertility Status of the Research Pastures at the Forage Systems Research Center

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University of Missouri, Columbia

Introduction

About 45 per cent of the farmland is pasture in Missouri. Pasture supported about 6,600,000 cattle in 1976. The fertility management of these pastures is an important item in the economical production of beef cattle in Missouri. Consequently, plant nutrient levels and distribution within the plow layer of the experimental pastures are important parts of this study.

Experiment

A. Pasture establishment. The soils of the pastures of this study were brought up to "soil test" by corrective treatments of limestone, rock phosphate and potash. The plantings of Kentucky 31 fescue were made during 1968-71, with the experimental grazing beginning in Dec. 1972. Quantities of limestone, rock phosphate and potash applied varied with an average of 6.3 tons of limestone, 1250 pounds of rockphosphate and 120 pounds of potash per acre applied to the 36 experimental pastures. The corrective treatments were applied by spreader trucks. Each pasture was either 9, 10, or 12 acres in size. Appropriate pastures were allotted to spring calving and fall calving herds. Each herd was divided so as to evaluate three nitrogen levels (0, 100, 200 pounds an acre) with two replications for both winter and summer pastures.

Ladino clover was over seeded annually on all pastures but survived only on the no nitrogen pastures and N fixed by the clover was the effective N for growth of fescue on these pastures. In addition to the corrective treatments, 0 + 60 + 60 was topdressed to all pastures in 1973 and 1974 and 0 + 40 + 60 topdressed in 1974 and 1976, as maintenance applications. The applications were made in February of each year.

B. Pasture fertility evaluation. The evaluation had two objectives: first, follow the change in soil nutrient levels at different depths under grazing conditions; and second, estimate the area size and number of samples from a field to get a good evaulation of fertility conditions of pasture soils.

C. Procedure. Corrective applications of limestone, rock phosphate and potash were plowed under and worked into the plow layer during seed bed preparation, with the intention to sample the pastures at the beginning of the grazing periods and at the termination of a study several years later. Dry weather in the fall of 1972 hindered soil sampling of some pastures until the fall of 1973. For sampling, pastures were visually divided into thirds making 3 or 4 acre sampling areas, depending on pasture sizes. The sampling technique is illustrated in Figure 1. By this technique, 13 individual samples (0-1 inch depth, 1-2 inch depth, etc.) were combined into each depth sample. Thirteen complete core samples made up a standard composite sample. Finally, thirteen separate "site" samples were made up of four complete core samples from a selected third of each pasture. All pastures of the spring calving herd and the winter pastures of the fall calving herd were sampled. All soil samples were tested in University of Missouri Area Soil Testing Laboratories by standard methods.

Results

A. General. Results given in this report are arithmetic summaries of the tests for the 1-inch depths to a depth of 6 inches of the pastures of the spring calving herd. Final sampling of the winter pastures of the fall calving herd is now underway.

1. Initial Sampling. Considerable variation occurred between soil test values at given depths of the different thirds (3 or 4 acres) of a given pasture. Possibly uneven distribution of corrective treatments by spreader trucks and incomplete mixing through the plow layer by discing may account for this variability.

2. Final Sampling. Wide variation between soil tests values of different areas of a given pasture also occurred at the termination of the studies. Grazing patterns and removal of forage as hay from some areas probably contributed to this variability.

B. Discussion. The P_2O_5 and exchangeable K soil test values given in Tables 1, 2, and 3 are averages of 6 determinations. However the considerable variation between the individual values should give good estimates of the soil nutrient conditions at the time of sampling.

1. Table 1 gives the soil test P_2O_5 and exchangeable K values for the separate 1-inch depths and the average values of these six depths of the winter pasture of the spring calving herd. No complete statistical analyses have yet been run on the data in this table, but it is remarkable how well the arithmetic averages agree with each other. Practically all forage produced on these pastures was consumed by the cattle on the six different pastures in

the group, and the only known source of nutrient removal would be in the live weight increase of the animals pastured.

Another point of interest is the distribution of P_2O_5 and exchangeable K in the different depths of the plow layer. The data for 1972 came from samples taken in October and the 2 upper inches reflect the 0 + 60 + 60 topdressed the previous February. Of special note is the apparent movement of both P_2O_5 and exchangeable K through the six inches as indicated by the results of samples taken in the fall of 1976. This extent of downward movement was not found in other pastures we have tested. Physical movement by cattle grazing these pastures when excessively muddy is a possible explanation, as the pastures are muddy in late fall and early spring.

The differences between the values obtained in 1972 and 1976 indicate that the annual maintenance application increased the P_2O_5 soil test by 100 lbs and the exchangeable K by 72 lbs. These values indicate that P_2O_5 and exchangeable K values were higher than necessary when no hay was removed and all forage was eaten by the cattle in the pastures.

2. Tables 2 and 3. It is difficult to pick put any real differences in soil test values given in Tables 2 and 3 with the possible exception of the exchangeable K values of the pastures getting no nitrogen. Apparently creep feeding calves on these pastures, which produced smaller quantities of forage due to limited nitrogen, increased the K content of these soils. On pastures getting nitrogen fertilizer and from which hay was occasionally removed, the K applied as maintenance fertilizer as well as that coming from creep fed grain was removed with the hay. Eventual statistical analyses of the data may point out more differences than these now apparent.

TABLE 1. Phosphate and Exchangeable Potassium Soil Test Values of Winter Pasture for the Spring Calving Herd.

Depth Inches	No Nitrogen P_2O_5 Soil Tests 1972	1976	Increase 1976-1972	100 lbs Nitrogen P_2O_5 Soil Tests 1972	1976	Increase 1976-1972	200 lbs Nitrogen P_2O_5 Soil Tests 1972	1976	Increase 1976-1972
0-1	250	436	186	238	405	167	256	432	176
1-2	191	306	115	177	317	140	184	348	164
2-3	148	232	84	165	267	102	169	264	95
3-4	154	181	27	157	237	80	137	268	131
4-5	155	210	55	188	247	59	167	229	62
5-6	143	229	86	170	243	73	209	218	9
0-6 Average	168	264	96	183	284	101	187	299	112
	Ex K Soil Tests			Ex K Soil Tests			Ex K Soil Tests		
0-1	336	532	196	409	543	134	479	521	42
1-2	229	314	85	244	329	85	269	307	38
2-3	174	238	64	168	241	73	180	249	69
3-4	155	208	53	143	212	69	141	216	75
4-5	150	191	41	137	192	55	140	209	69
5-6	162	194	32	136	190	64	146	212	66
0-6 Average	201	280	79	206	284	78	226	285	59

TABLE 2. Phosphate and Exchangeable Potassium Soil Test Values of Summer Pastures for Spring Calving Herd - Calves not Creep Fed.

Depth Inches	No Nitrogen P_2O_5 Soil Tests 1973	1976	Increase 1976-1973	100 lbs Nitrogen P_2O_5 Soil Tests 1973	1976	Increase 1976-1973	200 lbs Nitrogen P_2O_5 Soil Tests 1973	1976	Increase 1976-1973
0-1	392	448	56	380	375	-5	390	439	49
1-2	335	392	57	291	336	45	356	384	28
2-3	294	309	15	275	253	-22	337	375	38
3-4	207	239	32	215	265	50	280	299	19
4-5	142	209	67	225	215	-10	231	243	12
5-6	169	182	13	180	150	-30	170	172	2
0-6 Average	256	296	40	261	266	5	294	319	25
	Ex K Soil Tests			Ex K Soil Tests			Ex K Soil Tests		
0-1	565	487	-78	538	598	60	468	427	-41
1-2	363	370	7	370	444	74	299	298	-1
2-3	256	272	16	276	334	58	222	252	30
3-4	210	234	24	215	258	43	213	220	7
4-5	193	219	26	212	218	6	200	203	3
5-6	195	190	-5	204	192	-12	212	197	-15
0-6 Average	297	295	-2	302	341	39	269	266	-3

TABLE 3. Phosphate and Exchangeable Potassium Soil Test Values of Summer Pastures for Spring Calving Herd - Calves Creep Fed.

	No Nitrogen			100 lbs Nitrogen			200 lbs Nitrogen		
	P_2O_5 Soil Tests			P_2O_5 Soil Tests			P_2O_5 Soil Tests		
Depth Inches	1973	1976	Increase 1976-1973	1973	1976	Increase 1976-1973	1973	1976	Increase 1976-1973
0-1	397	413	16	428	442	14	382	416	34
1-2	298	364	66	363	369	6	320	365	45
2-3	279	290	11	303	345	42	283	272	-11
3-4	256	315	59	205	224	19	239	268	29
4-5	260	291	31	200	156	-44	271	370	99
5-6	294	242	-52	163	126	-37	193	293	100
0-6 Average	298	319	21	277	277	0	281	331	50
	Ex K Soil Tests			Ex K Soil Tests			Ex K Soil Tests		
0-1	510	668	158	478	464	-14	572	470	-102
1-2	398	551	152	295	306	11	383	342	-41
2-3	303	402	99	234	229	-5	322	290	-32
3-4	295	336	41	199	193	-6	276	233	-43
4-5	272	323	51	191	182	-9	229	207	-22
5-6	260	313	53	172	178	6	193	221	28
0-6 Average	340	432	92	262	259	-3	329	294	-35

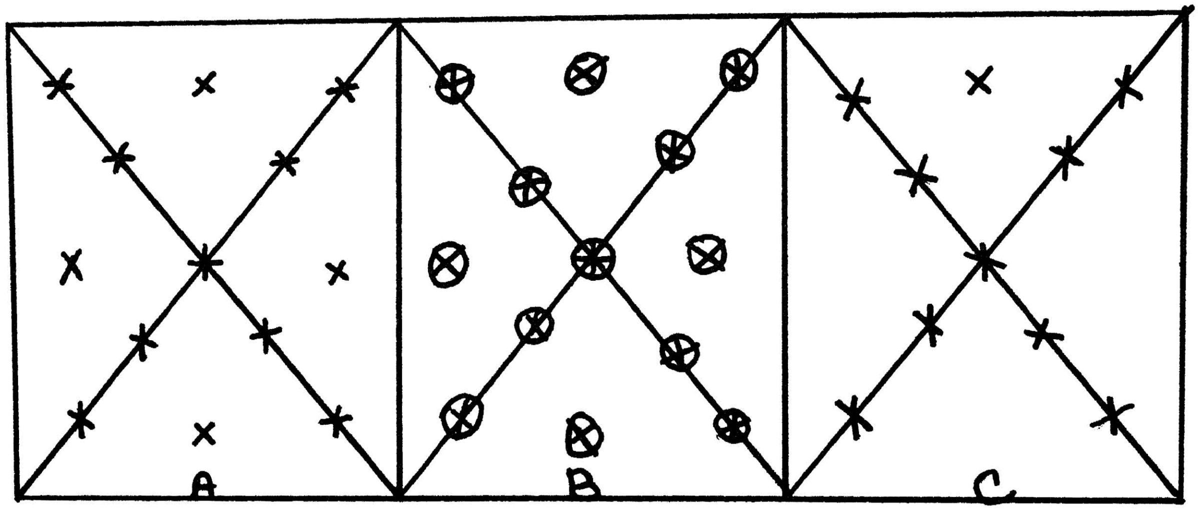


Figure 1. Diagram illustrating soil sampling technique. Crosses indicate 0-6 inch cores cut into six segments, each depth placed in appropriate sample bags. Also at each cross a 0-6 inch core was taken and the 13 cores combined to form a composite sample representing the standard soil sampling method. Circled crosses indicate that four additional 0-6 inch cores were composited into a single "site" sample to estimate variability within each pasture.

Forage Grass Growth Regulation

John Shelburne, Research Specialist in Agronomy
Forage Systems Research Center

A constant, consistent supply of forage is the concern of the cow and calf producer. The flush of growth in early summer followed by heading and lower quality forage are problems of these producers. A growth regulating substance that would flatten the growth curve while not lowering production, would be welcome. The elimination of seed stalks to irritate the eyes could also help in pinkeye control.

The growth regulator, N- 2,4-dimethyl-5-(trifluoromethyl) sulfonyl, (MBR 12325), used in this study stops the elongation of the seed stalk. This keeps the larger proportion of the above ground plant vegetative throughout the normal growing season. Therefore, the plant should be more palatable to animals.

Work done by University of Kentucky researchers over the last two years indicates that several quality factors are improved. One of these, acid detergent fiber (ADF), which is an excellent indicator of digestibility, shows a definite advantage to the treated forage (Table 1). Two more indicators, per cent cellulose and per cent total sugars, go hand-in-hand and show an advantage to the treated forage. Crude protein, on the other hand, shows slight advantage at times. This may be attributed to growth after precipitation when larger amounts of N are taken into the plant tissue. Dry matter production can be adversely affected at higher rates. At the rate used in the Missouri study here, no difference was found in crude protein between treated and untreated forage.

Our work this summer, with only a limited number of test animals, shows no difference in average daily gain with treated and untreated forage. The treated pasture was always more attractive, but the steers did not show any differences in weight gain. This in itself may be beneficial in that we did not lose any performance, and we did keep a more trim, pleasant looking pasture. There were no pinkeye problems in either pasture, so we can't show an advantage for or against one treatment or the other here.

While our work did not show an advantage to applying the growth regulator to pasture from the animal gain standpoint, it showed no disadvantage either. There are applications for a growth regulator of this type around the farm, such as around buildings where it is unhandy to clip grass, along road banks too steep to clip and places where other methods of beautification are too costly or impractical.

We feel that more research with this and possibly other growth regulators should be conducted. The dry spring and early summer (with less than normal rainfall of only 16.5" between Jan. 1 - July 31), plus the fact that the pasture used had not had any N applied in the last 5 years may partially account for the result. The number of steers per pasture, two, was not really sufficient. Also, the fact that we only had one pasture of each treatment should be considered. The size of the steers when put on pasture (750-825 lbs) may also have been too large.

Table 1

Acid Detergent Fiber Content of Fescue Forage.

University of Kentucky 1976[1]

Rate (kg/ha)	Date of Harvest				
	4/29	5/13	5/20	6/11	6/24
0	28.0	31.3	29.5	30.3	34.4
0.28	25.0	29.4	28.8	29.8	30.0
0.56	25.5	29.4	27.4	31.0	32.0
$LSD_{.05}$	3.9	2.5	1.6	1.0	2.3
$LSD_{.01}$	5.9	3.8	2.4	1.4	3.4

Table 2

Acid Detergent Fiber Content of Fescue Forage.

University of Kentucky 1975[1]

Rate (kg/ha)	Date of Harvest			
	5/2	5/6	5/13	5/20
0	27.1	30.3	34.8	39.1
0.28	26.2	29.0	32.5	36.0
0.56	27.6	29.9	32.8	37.4
$LSD_{.05}$	0.9	1.0	1.5	1.3
$LSD_{.01}$	1.2	1.4	2.0	1.7

1) Unpublished data from work by L. P. Bush, C. E. Ricek and graduate student Scott Glenn, all University of Kentucky.

Trefoil Seed Production

H. N. Wheaton, Department of Agronomy
University of Missouri-Columbia

Newer varieties of birdsfoot trefoil seem to have an advantage over Empire and Viking in that the new varieties are more persistent in Central and South Missouri.

However, getting adequate seed supplies has been difficult. Missouri climate is not the best for high seed yields. Yet in most years, enough seed can be harvested to make it profitable. Good seed yields are about 100 pounds of seed per year. Yields range from 40 to 120 pounds. Seed production is highest in the northern part of the state.

Good seed years usually are characterized by many sunny days, cool nights and dry weather from May 15th to July. Combining seed "direct" from the field is recommended for harvesting small acreages. Newly harvested seed should be cleaned and dried immediately. Harvest when the majority of the seed pods are ripe and turning brown. Dry weather at harvest time causes serious shattering; therefore, harvesting time is critical. One or two days delay in harvesting may make the difference between success and failure.

Birdsfoot trefoil generally requires honeybees and bumblebees for pollination. Wind and small insects have been generally ineffective. Bees prefer trefoil to many other flowering palnts and tend to congregate in flowering trefoil fields. However, for high seed yields, it is desirable to locate colonies of honeybees in or near the fields. Some beekeepers prefer trefoil to most other legumes as a source of nectar for honey.

Producing seed may lead to stand depletion in Missouri because of the stockpiling and rapid defoliation factors that usually accompany harvest. Grazing trefoil in May will usually cut down on the damage done by harvesting practices.

Forage Systems Research With Cows and Calves

J. A. Stricker, Superintendent
Forage Systems Research Center, and
Research Associate in Agricultural Economics

Introduction

Nitrogen fertilizer is normally applied to pastureland with the expectation that both forage production and production from animals utilizing the forage will be increased.[1] To be economically sound, the value of additional forage produced must be sufficient to at least pay the costs incurred to obtain the added production.

Determining the value of the additional pasture production is difficult because, unlike commodities such as corn or soybeans, there is no established market for pasture. Unlike grain, it cannot be transported without incurring substantial harvesting and handling costs; and the quality of pasture forage varies greatly depending on the season of the year utilized and plant species in the sward.

Pasture has no value as a human food. Its value depends upon its utilization by livestock, the efficiency of the livestock in converting forage to livestock products, and the market value of the livestock products after marketing and other associated costs have been paid.

The practice of creep feeding calves also presents a number of problems. If creep feed consumed by calves were a net addition to their diet, one would expect a partial efficiency of converting creep feed to gain of about 1.78:1. This theoretical partial feed conversion ratio is based on estimated NCR requirements for different rates of

[1] For a discussion of response of grass and grass legume mixtures to nitrogen applications, see "Cost-Return Comparisons of Nitrogen Fertilization of Tall Fescue Hay and Pasture" on page 2.

gain. A 331-pound calf, according to NRC tables, requires only .44 pound additional TDN to gain 1.98 vs. 1.65 pounds per day. This would produce a "partial" conversion efficiency of 1.78 pounds per pound of added gain. Actually, observed efficiencies in other research range from 5:1 to 20:1, strongly suggesting that a trade off of creep feed for grass and possibly milk is taking place (Jacobs, 1972). The profitability of creep feeding calves will depend on the price of feed, how efficiently the calves convert creep feed to additional gain, the composition of the gain (growth gain or fat), the price received for cattle when sold, as well as other considerations.

The seemingly simple questions of whether or not to apply nitrogen fertilizer to pasture, how much to apply, when to apply it, and should one creep feed calves, etc. become exceedingly complex.

The research reported here sheds some light on the problem but is by no means applicable to all situations. It does report findings for a limited number of forage cow-calf systems under controlled-replicated conditions. The results should serve as a guide in making decisions in pasture fertilization or creep feeding, particularly on fescue-legume pastures.

Description of the Research

Year around total systems research with beef cows and calves has been carried on at the Forage Systems Research Center since December 1971. The Center is located on the Cornett Farm which contains approximately 1100 acres in North Central Missouri. Research results from this center are expected to find application over most of Missouri as well as many areas in surrounding states.

The systems research project reported here was planned and is being supervised by an interdisciplinary group involving Dr. A.G. Matches, USDA-ARS and Agronomy; Dr. G.B. Thompson, Director, Texas Agricultural Experiment Station, Texas A&M University, Bushland, and formerly Professor of Animal Husbandry, University of Missouri-Columbia; (Dr. R.E. Morrow, Ass't. Professor of Animal Husbandry, has replaced Dr. Thompson); Dr. V.E. Jacobs, Professor of Agricultural Economics; Dr. F.A. Martz, Professor of Dairy Husbandry; Dr. H.N. Wheaton, Professor of Agronomy; Dr. H.D. Currence, Associate Professor of Agricultural Engineering; and J.A. Stricker, Superintendent, Forage Systems Research Center and Research Associate, Agricultural Economics. The project is administered by the Forage-Livestock Coordinator.

Variables for the research are presented in Figure 1. Four years of data from both the spring and fall calving herds are presented here. The study with the spring herd was discontinued in November 1975. The fall herd study was completed in late July 1977.

Experimental Animals and Management. Grade horned Hereford cows with a mature size (in average flesh) of about 1000 pounds bred to registered, production tested, and Polled Hereford bulls were used in this study. Breeding season began on May 1 in the spring herd and November 15 in the fall herd. One bull was used to breed the cows in each replication. Cows were observed for heat with the aid of vasectomized bulls wearing chin ball markers. Cows were either hand mated to the bull or bred AI with semen from the same bull. Breeding continued for approximately four heat cycles. About 60 days after the end of the breeding season, cows were palpated and open tester cows were replaced with pregnant cows at the beginning of the next annual cycle, which was November for the spring herd and late July or early August for the

SYSTEMS VARIABLES

Soil fertility treatments

- No nitrogen
- 100 lbs nitrogen/acre (40 lb summer 60 lb winter)
- 200 lbs nitrogen/acre (80 lb summer 120 lb winter)

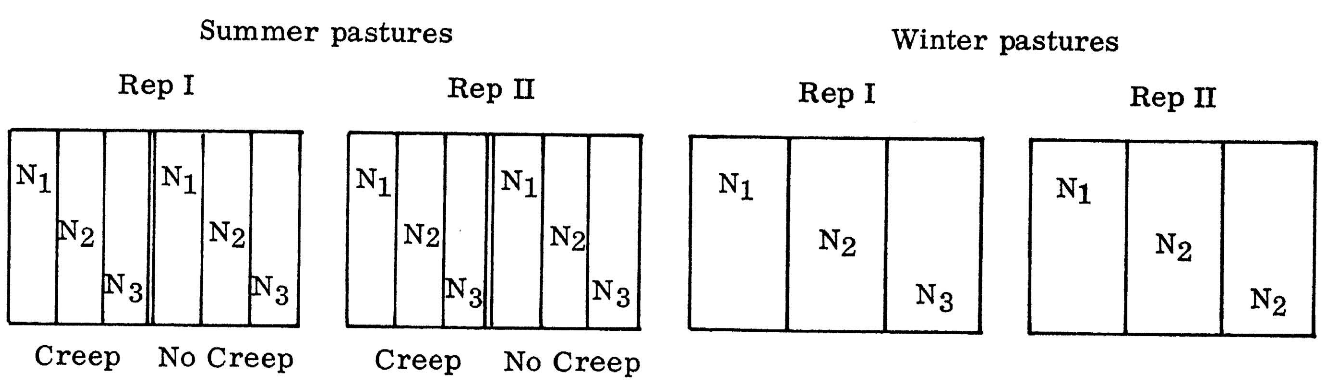
Calving season

- Spring calving herd (February, March, April)
- Fall calving herd (September, October, November)

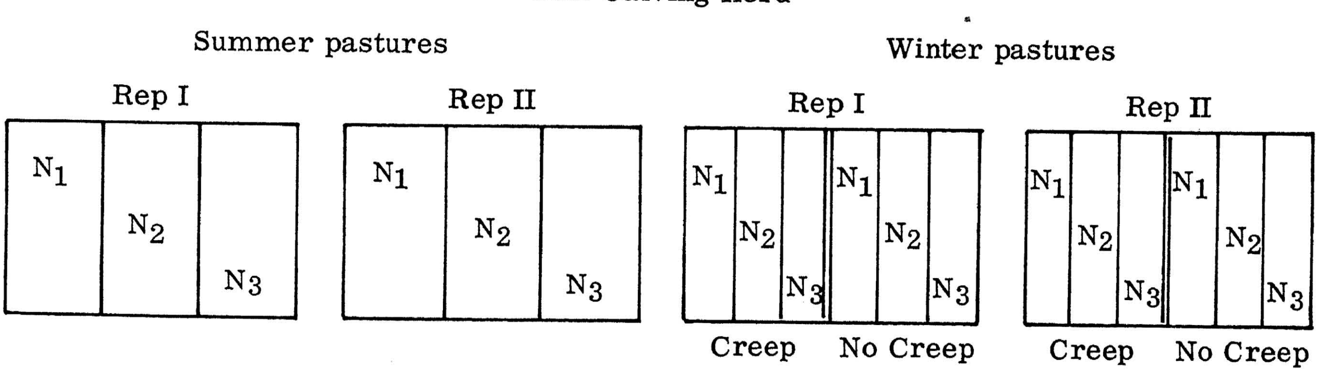
Supplemental feed for the calves

- Creep feed (Fed to spring calves in summer - fall calves in winter)
- No creep feed

Spring Calving Herd



Fall Calving Herd



fall herd.

Spring-dropped calves (February, March and April) were allotted along with their dams to the summer pastures, in late April, with half of the calves going to a creep-feed treatment and half to a no-creep-feed treatment within each nitrogen treatment. Fall-dropped calves (August, September, and October) with their dams were allocated to winter pastures, in mid-November, with half of the animals going to a creep-feed treatment and half to a no-creep-feed treatment within each nitrogen treatment. Creep feeding of the fall calves was discontinued when the animals were moved back to summer pastures in late April. Spring calves were weaned the last week of October or first week of November, and the fall calves were weaned in late June or early July.

Pastures and Pasture Management. For the winter phase, six, 12-acre pastures were provided for the spring herd and twelve, 6-acre pastures were provided for the fall herd while, during the summer phase, the spring herd utilized a total of 12 pastures with four each of 12, 10 and 9 acres for the 0, 100 and 200 pound nitrogen rates, respectively; and the fall herd a total of six pastures with two each of 24, 20 and 18 acres, respectively. All pastures were straight fescue swards to which one pound of ladino clover seed per acre was overseeded in late winter each year. Corrective applications of lime and rock phosphate were made according to soil test recommendations, when fescue was established in the late 1960's and early 1970's. Annual applications of 0 + 60 + 60 were made on all pastures in 1972 and 1973; this rate was changed to 0 + 30 + 60 in subsequent years. The annual nitrogen application of 0, 100 and 200 pounds per acre was split with

60 percent applied in late winter and 40 percent in mid-summer. Ammonium nitrate (NH_4NO_3) was the form of nitrogen used.

Spring growth in the winter pastures was cut in June and baled with an Allis-Chalmers Roto-baler.[2] Bales were left in place and regrowth allowed to accumulate. In mid-November, six tester cow-calf pairs from the fall herd were allotted to each of their 12 winter pastures, and 12 pregnant tester cows from the spring herd were allotted to each of their six winter pastures. Additional put-and-take animals were allotted to balance dry matter available on a per-head basis on all pastures. Movable electric fences limited the animals to 2 acres (1 acre in fall herd) at first and were moved in 1-acre (1/2 acre in fall herd) increments as each increment was cleaned up. During the first three winters (first winter for fall herd), dry matter available in each pasture was estimated by sampling accumulated regrowth and weighing a sample of hay bales; put-and-take animals were allotted accordingly with no adjustments during the grazing period. Imbalances sometimes developed necessitating moving fences more rapidly in some pastures than in others in order to maintain nearly constant grazing pressures. During the final winter (last three for the fall herd), animals were added or removed from the pastures to maintain constant grazing pressure and to allow fences to be moved at a uniform rate across treatment. Pasture forage usually carried the animals into late March or early April. Supplemental hay was fed to carry the animals into the beginning of the summer phase in late April or early May.

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[2]Mention of a proprietary product does not constitute a guarantee or warranty of the product by the University of Missouri or the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

Each summer pasture was divided into three rectangular paddocks. One paddock in each pasture was mowed and hay harvested with each individual paddock harvested every third year. The first year, in the spring-herd pastures, hay was baled with an Allis-Chalmers Roto-baler[2] and the bales consumed in place later in the season. In subsequent years, the hay was harvested and removed from the pasture for both herds. Six tester cows and calves in the spring herd and 12 tester cows and calves in the fall herd were rotationally grazed on the pastures through the grazing season. Additional put-and-take animals were added to balance dry matter available on a per-head basis across treatments.

Data Collected. Cows were weighed at the beginning and end of each phase after an overnight shrink from water. Ending weights from one phase became the beginning weight for the next. Put-and-take animals were weighed when added and again when removed from the pastures. Beginning in January 1975, all animals were weighed on approximately 28-day intervals. Calf birth dates and birth weights were recorded; and at weaning, the calves were weighed and graded. The amount of creep-fed calves over the non-creep-fed calves was calculated. Data were recorded on all animals; however, only data on the tester animals and put-and-take animals were used to determine carrying capacities of pastures (Mott and Lucas, 1952).

Carrying capacities of the pastures were calculated in metabolic animal unit months (AUM). AUM's were used to compensate for differences in animal size, both that of the tester and put-and-take animals. The metabolic animal unit month figure is a unit of measure of the biomass supported by each pasture.

The amount of hay fed (from sources other than each individual pasture) and/or removed was recorded. Hand clipping samples of the sward were taken periodically and hand separated to determine botanical composition. Samples were also analyzed for in vitro dry matter digestibility (IVDMD) and crude protein.

The physical results were subjected to economic analysis to determine the cost of increasing calf production, above that produced by fescue-ladino clover pastures without nitrogen, by use of nitrogen fertilizer on pastures, and/or creep feed for the calves.

Results of Four Years Research with Fall-Calving Cows and Calves With a Comparison of Spring and Fall Calving

Pasture Carrying Capacity and Composition. Annual carrying capacity of pastures was increased by the addition of chemical nitrogen. The

Table 1. Pasture carrying capacity and annual cow gain or loss.

	Spring			Fall		
	Adj. 365 day AUM/A	AUM/A winter phase only	365-day cow gain or loss (lb.)	Adj. 365 day AUM/A	AUM/A winter phase only	365-day cow gain or loss (lb.)
1971-72	6.6	6.4	-68.6			
1972-73	7.2	4.8	+65.7			
1973-74	8.3	7.2	-69.1	4.9	6.9	-117.8
1974-75	9.9	5.9	- 2.1	5.5	7.0	+ 40.9
1975-76				6.2	9.2	+ 76.0
1976-77				4.8	7.0	- 22.2
O#N/A	6.2	5.1	- 8.2	4.1	5.8	- 6.3
100# n/A	7.6	6.0	-12.0	5.5	7.8	+ 4.5
200# N/A	8.7	7.1	-35.3	6.3	9.0	- 14.15
All Tmts.	7.5	6.1	-18.5	5.3	7.5	- 7.1
Creep Feed			-22.2			- 2.8
No Creep Feed			-14.8			- 14.0

first 100 pounds of nitrogen increased carrying capacity 23 and 34 percent in the spring and fall herd pastures, respectively, above the no-nitrogen treatment. The second 100 pounds of nitrogen increased the carrying capacity an additional 17 and 21 percent.

Spring herd pasture carrying capacities exceeded that of the fall herd pastures by 2.2 AUM/A on an annual basis. However, the fall herd winter pasture carrying capacities were greater than that of the spring herd winter pastures by 1.4 AUM indicating an inordinately low carrying capacity for the fall herd summer pastures. The fall herd summer pastures are located on a less desirable site than the spring herd summer pastures, being more severely eroded. Winter pastures for the spring and fall herd are adjacent and on similar soils; consequently, for the purposes of comparing spring and fall calving systems, we will assume no real differences exist in pasture carrying capacity due solely to the calving season.

Botanical composition of the pastures was changed by the addition of chemical nitrogen. Clover content of the pastures declined as the nitrogen rate was increased (Taylor et al, 1959). Other researchers have reported that the presence of a legume in a sward furnishes nitrogen to the sward (Templeton and Taylor, 1966; Kroth and Mattas, 1971; Tesar, 1974; Matches et al, 1972), improves animal gain (Blazer et al, 1969; Goode et al, 1969; Anderson and Safley, 1967) and improves conception rates of cows (Cmarik, 1972; Lechtenberg et al, 1975).

Botanical composition samples were taken from the grazed portion of pastures and may not show as high a percentage of legumes as samples taken from under pasture cages or from ungrazed portions of pastures.

Table 2. Average botanical composition[1/], crude protein, and digestibility (IVDMD) of pastures, 1975[2/]

Nitrogen Treatment	% Clover	% Fescue	% Other	% Protein	% IVDMD
		Spring Herd Summer Pastures			
0# N/A	11.33	86.46	2.29	11.88	52.53
100# N/A	1.85	95.32	2.82	11.82	50.94
200# N/A	.15	95.85	3.99	15.24	54.65
		Fall Herd Summer Pastures			
0# N/A	3.79	96.08	.69	9.17	47.04
100# N/A	1.64	97.69	.67	10.10	47.55
200# N/A	.00	99.60	.40	11.95	49.65

[1/] Average of 10 samples in spring herd pastures and 9 samples in fall herd pastures taken at 2-week intervals 5/13-9/22.

[2/] Botanical composition on a dry weight basis.

Digestibility (IVDMD) and crude protein content of summer pastures increased with increasing nitrogen rate. This apparent increase in quality was not reflected in improved animal performance. Crude protein content of hay and stockpiled regrowth consumed during the winter phase increased along with nitrogen rate, as did digestibility of the stockpiled regrowth. Digestibility of hay in fall herd winter pastures declined with the first 100 pounds of nitrogen and increased with the second 100 pounds of nitrogen. However, the differences in digestibility of hay were so small that they may be insignificant.

Table 3. Average digestibility (IVDMD) and crude protein content of hay and stockpiled regrowth, 1975.

Nitrogen Treatment	Hay[1/] % IVDMD	Hay[1/] % Crude Protein	Stockpiled Regrowth[2/] % IVDMD	Stockpiled Regrowth[2/] % Crude Protein
		Spring Herd Winter Pastures		
0# N/A	42.51	7.16	49.68	7.75
100# N/A	41.43	7.47	52.65	8.90
200# N/A	43.46	8.72	56.80	12.77
		Fall Herd Winter Pastures		
0# N/A	47.24	8.48	Values for stockpiled regrowth should be very close to those for spring herd pastures	
100# N/A	46.74	9.48		
200# N/A	45.87	11.39		

[1/]Average cutting date for hay in spring herd winter pastures was 6/26/75, for fall herd pastures 6/17/76.

[2/]Values for stockpiled regrowth are the result of 10 observations taken at 2-week intervals from 11/7/75 to 3/19/76.

Cow Performance. Conception rates of fall-calving cows were 18.2 percentage points greater than spring-calving cows. The first year's conception data from the spring herd were not used because the cows went on pasture later than normal, and vasectomized bulls were not used to aid heat detection.

Table 4. Conception rate of cows.

	Spring	Fall
	% Tester cows settled	% Tester cows settled
1972-73	75.2	
1973-74	68.0	68.1
1974-75	50.0	84.7
1975-76		87.4
1976-77		90.3
	No Creep Feed For Calves	
0# N/A	80.0	79.2
100# N/A	56.6	81.2
200# N/A	27.8	83.3
	Creep Feed For Calves	
0# N/A	77.7	87.5
100# N/A	74.9	83.3
200# N/A	69.4	81.2
All cows	64.4	82.6

A decline in conception rates in the spring herd was observed over three years while an opposite trend was noted in the fall herd. Spring herd conception rates also declined as nitrogen rate was increased. Feeding creep feed to spring calves appeared to have a positive effect on conception rates although the reason for this is not understood and cannot be explained, especially since this phenomenon was observed in a year when calves consumed little or no creep feed. Fall herd conception rates varied slightly with both nitrogen rate and creep feeding but the differences were small and probably insignificant. The most striking observation one can make from this data is that the agent causing a decline in conception rates in the 200 pound nitrogen-treated pastures in May and June was either not present or inactive in November and December when the fall calving cows were bred.

Table 5. Calf weaning data.

	Adjusted 205-day weight	Actual weaning weight	Weaning age (days)	Feeder grade
		Spring Calves		
1971-72	435.3	462.5	245.0	14.1
1972-73	426.4	439.8	231.6	13.5
1973-74	444.8	419.4	207.7	13.3
1974-75	437.5	480.1	232.2	13.6
No Creep Feed				
0# N/A	429.4	443.9	229.6	13.6
100# N/A	405.1	422.1	232.2	13.2
200# N/A	392.1	399.9	225.6	13.0
Creep Feed				
0# N/A	483.4	499.4	227.9	14.0
100# N/A	450.1	469.0	231.4	13.9
200# N/A	456.2	468.4	228.0	14.0
All Spring Calves	436.0	450.4	229.1	13.6
		Fall Calves		
1973-74	349.7	405.9	265.2	13.3
1974-75	341.7	434.4	287.3	13.5
1975-76	379.6	499.8	289.8	13.1
1976-77	369.5	494.2	269.7	12.9
No Creep Feed				
0# N/A	341.6	425.9	285.0	12.9
100# N/A	333.7	430.0	285.6	12.9
200# N/A	321.4	408.4	284.2	12.7
Creep Feed				
0# N/A	380.7	497.9	282.6	13.7
100# N/A	396.4	492.2	243.4	13.4
200# N/A	380.9	497.3	284.4	13.5
All Fall Calves	359.1	458.6	277.5	13.2

<u>Calf Performance</u>. Among the three nitrogen treatments, spring calf adjusted 205-day weaning weights were higher from the no-nitrogen treatment, exceeding the 100-pound nitrogen rate by 24.3 pounds and 33.3 pounds for the no-creep and creep treatments, respectively, and the 200-pound nitrogen rate by 37.3 and 27.2 pounds. Adjusted weaning weights for the non-creep fed fall calves were greatest on the no-nitrogen treatment exceeding the 100-pound nitrogen treatment by 7.9 pounds and the 200 pound nitrogen treatment by 20.2 pounds. However, in the creep-fed group, calves from the 100-pound nitrogen treatment were heaviest, exceeding the no-nitrogen treatment by 15.7 pounds and the calves from the 200 pound treatment by 15.5 pounds Creep-fed calves outweighed non-creep-fed calves in both herds.

Adjusted 205-day weights of spring calves were 76.9 pounds heavier than the adjusted 205-day weights of fall calves. Actual weaning weights, however, varied by only 8.2 pounds. Fall calves averaged 48 days older at weaning exhibiting a slower rate of growth than the spring calves. Because fall calves were on the pastures longer than the spring calves, they placed greater demands on the pastures than did spring calves. The total AUM requirement per cow-calf unit in the spring herd totalled 14.5 AUM/yr while AUM per cow-calf unit in the fall herd totalled 15 AUM/yr.

Spring calf adjusted weights varied only 18.4 pounds over four years. The lowest weight was observed in 1973, a year when creep-fed calves consumed little or no creep feed. Adjusted weight of fall calves varied 37.9 pounds over four years. Creep feed consumption by creep-fed calves in the fall herd was low in 1973-74 and in

1974-75 while it was very good in 1975-76 and 1976-77, averaging over 750 pounds/calf. Calves sometimes experienced difficulty learning to eat creep feed. The problem did not appear to be associated with an individual treatment or herd. Consequently, beginning in 1975, calves were placed in an enclosure around the creep feeders for a few hours a day at the beginning of the phase when creep feed was fed until calves became accustomed to eating the feed. The creep feeding period averaged 145 days for the fall calves and 180.5 days for the spring calves.

Total consumption of creep feed or creep consumption per pound of additional gain, over non-creep-fed calves, did not appear to be affected by nitrogen treatment.

Table 6. Average Creep Consumption, additional gain and feed efficiency.

Nitrogen treatment	Average creep consumption (lbs)	Additional gain (lbs)	Pounds of feed per lb of additional gain
	Spring Calves		
No nitrogen	557	63.1	8.8
100# nitrogen	493	50.5	9.8
200# nitrogen	542	67.4	8.0
All spring calves	531	60.0	8.9
	Fall Calves		
No nitrogen	743	68.0	10.9
100# nitrogen	653	62.0	10.5
200# nitrogen	697	94.0	7.4
All fall calves	698	74.7	9.6

Economic Evaluation. Calf production per acre per year for both spring and fall herds in presented in Table 7. Actual weaning weights of calves were used to calculate annual production. The additional age of fall calves is charged against the fall pasture systems by increasing the biomass of the cow-calf unit supported by these systems by .5 AUM above that of the spring herd cow-calf unit.

Additional cow-calf units carried are over and above those carried by the base system of fescue-ladino clover pastures with no nitrogen and no creep. If 160 acres were available to produce cows and calves, the base system with fall-calving cows would theoretically carry 65.6 cow-calf units per year and produce 321.5 pounds of calf weight per cow-calf unit. When the 100 pound nitrogen system is used, a total of 81.6 cow-calf units could be carried on the same 160 acres an increase of 16 cow-calf units, with an average production of 330.4 pounds of calf weight. In this case, more animals were carried on the same land base; but also the production of all animals in the herd was increased. With the 200 pound nitrogen system, 93 cow-calf units could theoretically be carried, an increase of 27.4 above the base system, with an average of 320.3 pounds of calf weight per cow-calf. While more animals are carried on the latter system, average production per unit decreased. This decrease was not only for the added cow-calf units but for all units in the herd. Carrying capacity of the 160 acres increased 24 percent and total production increased 28 percent with the 100 pound nitrogen system; while with the 200 pound nitrogen system, carrying capacity increased 42 percent above the base system; and total production increased only 41 percent.

Hay produced per acre in each spring herd system averaged 39, 52, and 58, 50-pound bales from the 0-, 100-, and 200-pound nitrogen treatments, respectively; while in the fall herd, the average was 32, 50, and 62, 50-pound bales. In other words, if both hay and pasture production were averaged in all acres in each system, the above number of bales were produced with the balance of the production from each acre from pasture. All hay was assumed to be utilized within each system. Small amounts of surplus or deficit hay were added to or subtracted from pasture carrying capacity by assuming 900 pounds of hay would satisfy the requirement for one AUM.

Cow ownership costs of $40 per cow per year are charged for additional cow-calf units carried. Included in this charge: cost of salt, minerals, veterinary expenses, marketing expenses for calf and interest charged on borrowed capital or foregone on equity. All costs were added together and divided by the added calf weight produced to give the cost for producing the added calf weight.

Table 7 computes pounds of calf produced on a per-acre basis using both observed conception rates and an assumed 90 percent conception rate. Actual weaning weights are used in this analysis rather than adjusted 204-day weights. Adjusted weights are convenient for comparing calves at a given time; but for an economic study, actual weaning weight is what is available to be sold. The actual weaning weight is the source of revenue to pay the costs of increasing production.

Table 7. Pounds of calf produced per acre.

Nitrogen treatment	Cow-Calf units per acre	x	Conception rate	x	Actual weaning weight (lb)	=	Lb calf per acre	Assumed % calving rate lb/A
			Spring Herd[1/]					
	No Creep Feed							
0# N/A	.43		80.0		443.9		152.7	171.8
100# N/A	.52		56.6		422.1		124.2	197.5
200# N/A	.60		27.8		399.9		66.7	215.9
	Creep Feed							
0# N/A	.43		77.7		499.4		166.8	193.3
100# N/A	.52		74.9		469.0		182.7	219.5
200# N/A	.60		69.4		468.4		195.0	252.9
All spring calves	.52		64.4		450.4		148.0	210.8
			Fall Calves[2/]					
	No Creep Feed							
0# N/A	.41		79.2		425.9		138.3	157.2
100# N/A	.51		81.2		430.0		178.1	197.4
200# N/A	.58		83.3		408.4		197.3	213.2
	Creep Feed							
0# N/A	.41		87.5		497.9		178.6	183.7
100# N/A	.51		83.3		492.2		209.0	225.9
200# N/A	.58		81.2		497.3		234.2	259.6
All fall calves	.50		82.6		485.6		200.6	218.5

[1/] Spring cow-calf unit per year = 14.5 AUM.

[2/] Fall cow-calf unit per year = 15.0 AUM.

Pasture carrying capacity in cow-calf units per acre from Table 7 is used in Table 8 to find the additional (marginal) carrying capacity in cow-calf units obtained from the 100- and 200-pound nitrogen treatments over the no-nitrogen treatment. Additional calf weight per acre in Table 8 is also computed from Table 7 by calculating the difference in calf weight produced per acre between the no-nitrogen, no-creep feed treatment and the 100- and 200-pound nitrogen treatments as well as the creep-feed treatments.

Table 8a. Spring calving herd per acre cost of increasing calf production and calf prices needed to pay costs with both observed and assumed 90% calving rates.

	No Creep Feed			Creep Feed		
	0 lb N/A	100 lb N/A	200 lb N/A	0 lb N/A	100 lb N/A	200 lb N/A
	(Base system)					
1. Cow-calf units/A[a]	.43	.52	.60	.43	.52	.60
2. Add'l cow-calf units carried/A[b]	--	.09	.17	--	.09	.17
3a. Add'l lb/A of calf produced-observed calving rate[a]	--	-28.50	-86.00	14.10	30.00	42.30
3b. 90% calving rate[a]	--	25.70	44.10	21.50	47.70	81.10
4. N cost per A w/N @ 20¢/lb	--	$20.00	$40.00	--	$20.00	$40.00
5a. Creep cost/A with feed @ 5¢/lb - observed calving rate[c]	--	--	--	$9.30	$9.60	$11.28
5b. 90% calving rate[c]	--	--	--	10.78	11.54	14.63
6. Cost of owning add'l cows[d]	--	$3.60	$6.80	--	$3.60	$6.80
7. Cost of harvesting add'l hay produced @ 30¢/bale[e]	--	$6.50	$9.50	--	$6.50	$9.50
8a. Total added costs/A observed calving rate[f]	--	$30.10	$56.30	$9.30	$36.10	$67.58
8b. 90% calving rate	--	30.10	56.30	10.78	41.64	70.93
9a. Calf prices/lb needed to pay added costs[h]	--	j	j	$.66	$1.20	$1.60
9b. 90% calving rate[i]	--	1.17	1.28	.50	.87	.87

Table 8b. Fall calving herd per acre cost of increasing calf production and calf prices needed to pay costs with both observed and assumed 90% calving rates.

	No Creep Feed			Creep Feed		
	0 lb N/A	100 lb N/A	200 lb N/A	0 lb N/A	100 lb N/A	200 lb N/A
	(Base system)					
1. Cow-calf units/A[a]	.41	.51	.58	.41	.51	.58
2. Add'l cow-calf units carried/A[b]	--	.10	.17	--	.10	.17
3a. Add'l lb/A of calf produced-observed calving rate[a]	--	39.80	59.00	40.30	70.70	95.90
3b. 90% calving rate[a]	--	40.20	56.00	26.50	68.70	102.40
4. N cost per A w/N @ 20¢/lb	--	$20.00	$40.00	--	$20.00	$40.00
5a. Creep cost/A with feed @ 5¢/lb-observed calving rate[c]	--	--	--	13.33	13.87	16.41
5b. 90% calving rate[c]	--	--	--	13.71	14.99	18.19
6. Cost of owning add'l cows[d]	--	$4.00	$6.80	--	$4.00	$6.80
7. Cost of harvesting add'l hay produced @ 30¢/bale[e]	--	$5.53	$9.11	--	$5.53	$9.11
8a. Total added costs/A observed calving rate[f]	--	$29.53	$55.91	$13.33	$43.40	$72.32
9a. Calf prices/lb needed to pay added costs[h]	--	$.74	$.95	$.33	$.61	$.75
9b. 90% calving rate[i]	--	.73	1.00	.52	.65	.72

Footnote from Tables 8a and 8b

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[a]From Table 7

[b]Cow-calf units carried per acre over the number carried in the base system

[c]Cow-calf units per acre (Table 7) x calves per cow x lb of feed consumed per calf (Table 6) x price of feed per lb.

[d]Additional cow-calf units above base system (line 2) are needed to utilize added forage. Annual ownership costs assumed total $40.00 and include: interest on borrowed money on forage and on equity, salt and mineral, personal property tax, veterinary expenses, marketing expenses for calf.

[e]Hay baled per acre for each of the nitrogen treatments averaged 32, 50, and 62 for the 0 lb/A, 100 lb/A, and 200 lb/A, respectively, from the fall herd pastures, and 39, 52, and 58 in the spring herd.

[f]Sum of lines 4, 5a, 6, and 7

[g]Sum of lines 4, 5b, 6, and 7

[h]Line 8a divided by line 3a

[i]Line 8b divided by line 3b

[j]Since, as nitrogen rate was increased, total calf weight produced per acre decreased, there is no price at which the value of added calf weight will pay the cost of the nitrogen (there is NO ADDED calf weight).

The additional costs involved in increasing production in the nitrogen fertilized or creep fed systems are added together and divided by the additional pounds of calf weight produced; the resulting figure is the marginal cost of increasing calf production. Economic theory tells us that in order for increased production to be profitable, the marginal cost must equal marginal revenue. In order to cover the costs generated in this study, the additional calf weight produced must sell for an amount equal to the figure in line 9a or 9b in Table 8.

The results of this study do not tell us if it is profitable to raise calves. This study shows the costs involved in increasing production on a year-around forage system by using nitrogen fertilizer and/or creep feed for the calves over production on fescue-ladino clover pastures. Costs of increasing production in the fall calving herd were lower than costs of increasing production in the spring herd. The lower costs in the fall herd are a reflection of the higher conception rate of cows coupled with higher weaning weights of calves on the 100- and 200-pound nitrogen systems.

Spring Calving vs. Fall Calving

Calves from the spring calving herd gained more rapidly from birth to weaning than calves from the fall calving herd. The fall calves were weaned about 48 days later than the spring calves; and, as a result, actual weaning weights were similar. Because the actual calf weaning weight is what is available to be sold, it is an important criterion in evaluating season of calving. The fall calves were on the pastures longer and, consequently, consumed more forage. The last part of the pre-weaning period for the fall calves was during the period of most abundant forage growth; and, as a result, calves may have been able to utilize some forage that might otherwise have been wasted.

To a cow-calf producer, calf weight is important; but perhaps the number of calves produced from a given number of cows is more important or, in other words, the percent of cows that breed back and calve the next season is significant. In the spring calving herd, cows on fescue-ladino clover pastures with no nitrogen had a relatively high conception rate; but on systems where nitrogen fertilizer was used, conception rates declined. Use of nitrogen fertilizer did not appear to affect the conception rates on systems where calves received creep feed. Conception rates for the cows in the fall calving herd were high for all treatments and increased each year.

Results from the research at the Forage Systems Research Center show no clear advantage for either spring or fall calving. The decision to calve in either season will depend on a number of other factors. Important points to consider may be: when calves are to be marketed, seasonal work load of other farm enterprises, type of farming operation (grain crops or forage), and size of the beef herd. On grain farms where cows are used to clean up crop residues in the fall and winter, early spring calves may fit in best when calving can be completed before field work begins in the spring. If calves are normally marketed in late August or September, fall calves can be marketed as yearlings when spring calves would have to be weaned early and sold at a light weight.

Some producers with large herds prefer to calve in both spring and fall. Herd bulls can be used on twice as many cows per year; heifers can be calved at 2 1/2 years of age rather than at 2 or 3 years, and the labor load is spread more evenly over the year.

The decision of when to calve will, therefore, need to be based on a number of considerations but mainly how the cow-calf enterprise fits in with the total farming system.

Post-Weaning Studies with Fall Calves -- Preliminary

After the fall calves were weaned, they were brought together into one group and grazed as a group for approximatly 112 days. This post-weaning or backgrounding phase was conducted to measure carry-over effects of pre-weaning nitrogen fertilization and creep-feeding treatments. The steers from the 1975-fall calf crop were continued from the post-weaning phase into a finishing phase. A preliminary report of the finishing phase can be found in this report.

Initial weight, final weight, and gain during the post-weaning phase is presented in Table 9 for an average of 3 years. The non-creep fed calves gained 5.1 pounds more during the post-weaning phase than the creep-fed calves. This may be thought of as compensatory gain and narrowed the difference in weight between the non-creep-fed and creep-fed calves from 61.4 pounds to 56.3 pounds. The greatest amount of compensation occurred in the calves from the 100-pound nitrogen treated pastures. Calves from the non-creep treatments gained 9.5 pounds more than those from the creep-fed treatments narrowing the difference between the two groups from 57.5 pounds to 48.0 pounds at the end of the period.

Table 10 presents total body fat content of calves at the beginning and end of the post-weaning phase. Calves from the creep-fed treatments were fatter than the non-creep fed treatments, as one would expect. Calves from the no-nitrogen pasture treatments gained the most body fat during the post-weaning phase and also the most weight.

Calves from the 1976 fall calf crop are currently on the post-weaning phase. Steers from this group will be continued on feed after the end of this period. Heifers will be bred to calve in the spring of 1979. Data from the heifers will be gathered to see what effect, if any, pre-weaning, nitrogen, and creep-fed treatments on fescue-ladino clover pastures have on the maternal ability of heifers kept for mother cows.

Table 9. Initial weight, final weight, and gain of fall calves on post-weaning phase, FSRC, 1973-74, 1974-75, and 1975-76.

Pre-weaning treatment	Initial weight	Final weight	Weight gain
No Creep Feed			
0# N/A	399.0	508.7	109.7
100# N/A	406.0	510.4	104.4
200# N/A	385.1	482.4	97.4
Average No Creep	396.7	500.5	103.8
Creep Feed			
0# N/A	457.0	561.2	104.2
100# N/A	463.5	558.4	94.9
200# N/A	453.9	550.7	95.2
Average Creep Feed	458.1	556.8	98.7

Table 10. Calf body composition of beginning of post-weaning phase (2 yrs) and end of post-weaning phase (1 yr) based on whole body counter (K_{40} counter)

Pre-weaning treatment	Initial fat (%)	Ending fat (%)	Percentage points change
0# N/A	11.66	13.70	+ 2.04
100# N/A	11.63	12.65	+ 1.02
200# N/A	11.32	12.45	+ 1.13
No Creep Feed	10.41	12.32	+ 1.90
Creep Feed Fed	12.65	13.55	+ .90

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Feedlot and Carcass Performance of 1975 Fall Steers

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University of Missouri-Columbia

In an effort to expand on the information we can provide from forage systems research, we arranged to feed out some steers to characterize their feedlot performance and carcass traits. Twenty creep fed steers and twenty-two steers not creep fed from the 1975 fall calf crop from pre-weaning nitrogen fertilization treatments on fescue-ladino clover pastures, were selected to go into the feedlot at the South Farm of the University of Missouri-Columbia in November, 1976 after being grazed on pasture at the Cornett Farm. It's traditional to compare slaughter cattle by constant weights, days on feed or visual appraisal of quality grade. However, large variations often occur within and between different pens. Keeping in mind that average daily gains and feed efficiency are strongly related to physiological maturity, and because we have the distinctive ability to estimate body composition with the whole body counter, we decided to feed each steer to 26 per cent predicted body fat. Individual steers were slaughtered when they reached this end point regardless of their weight or time on feed.

After weaning, the calves were pastured together during the drouth-stricken summer of 1976. Even though the steers were pastured together throughout the summer, the creep fed steers still distinctly outweighed the no creep steers on November 4th when they arrived in Columbia (Table 2). In an effort to characterize the abilities of these steers under practical yet differing conditions, we decided to split the creep and no creep groups so that half of each group received either a high or low energy feedlot ration (Table 1). All steers were implanted with RALGRO every 100 days and fed Rumensin[a] at the rate of 300 mg/head/day.

The performance data for three of the four goups fed is shown in Table 2 (a few no creep low energy LELE fed steers are still on feed). As we indicated, the no creep group (LEHE) went into the lot about 80 pounds lighter than the creep fed groups (HEHE and HELE). Although we don't show the data, early weight gains favored the no creep group on the high energy ration. This observation is logical and was attributed to compensatory gain. However, we did not note the same on the cattle fed the low energy ration.

We were pleased with the gains attained through the winter. For the first 90 days high energy fed steers gained about 2.8 pounds per day and low energy fed steers gained about 2.2 pounds per day. The Rumensin probably increased gains on the low energy ration but not the high energy ration.

Although the no creep high energy steers started out with a higher ADG, they finished the trial with a poorer ADG and consequently were slaughtered at a lighter weight than their creep fed counterparts. We think it is interesting to note that even though the creep fed high energy steers finished 80 pounds heavier, their carcass fat thickness and yield grade were identical to no creep high energy steers (Table 3). Table 2 also shows that creep fed steers on the low energy ration had heavier slaughter weights than LEHE. It may be that preweaning nutritional environment can strongly affect rate of physiological maturity.

[a]Provided courtesy of Eli Lilly and Company, Greenfield, Indiana.

Table 3 reveals that when the whole body counter predicts body fat to be near or at 26%, the carcass data from steers on the same ration were also similar. Apparently, the carcasses from cattle on the low energy ration will be leaner than those from the high energy ration. Since the whole body counter predicts body composition and not necessarily carcass composition, we are studying two possible answers for above differences. First, all cattle were shrunk 12 hours before counting, but the low energy cattle probably still had more fill at the end of 12 hours and that affected per cent fat calculations. Second, fat distribution within the body may be altered by varying nutritional energy at different stages in the growth curve. Therefore, we have been measuring the fat in the entire viscera and in the muscle in attempts to explain differences.

Our data are incomplete due to the time required for laboratory analyses and the slow maturing rate of a few steers. However, we are planning to continue measuring the affects that the systems at the Forage Systems Research Center make on production and carcass traits of slaughter cattle.

Table 1

FEEDLOT RATIONS FOR FALL 1975 STEERS

Energy Density	Dry Rolled Milo	Ground Fescue Hay	Prot-Min Supp
High	78%	16%	6%
Low	47%	47%	6%

Protein-Mineral Supplement Composition

Ingredient	%	
Ground shelled corn	67.8	
Soybean meal	12.5	
Urea	9.4	
Limestone	4.0	
Dical PO_4	1.5	
Trace mineral salt	2.8	
Vitamin A-D premix	1.5	(about 25,000 units A/day and 4700 units D/day)
Rumensin	---	

Table 2

FEEDLOT PERFORMANCE OF FALL 1975 STEERS

Treatment[a]	Wt_o[b]	Wt_f[c]	ADG[d]	DOF[e]	Total Wt Gain
HEHE	606	1050	2.58	176	443
LEHE	513	971	2.48	187	458
HELE	586	1024	1.93	227	438

[a]Where HEHE = high energy preweaning (creep) and high energy ration in feedlot and LEHE = low energy preweaning (no creep) and high energy ration in feedlot, etc.

[b]Weight into feedlot, pounds.

[c]Slaughter weight, pounds.

[d]Average daily gain.

[e]Days on feed.

Table 3

CARCASS DATA OF FALL 1975 STEERS

Treatment	%fat[a]	Carc wt[b]	%dress[c]	Fat thickness[d]	KPH[e]	REA[f]	YG[g]	QG[h]
HEHE	27.3	613	60.4	0.50	2.3	10.5	3.2	8.0
LEHE	26.3	554	59.0	0.50	2.5	9.8	3.2	7.8
HELE	26.1	569	57.6	0.36	1.7	10.6	2.5	7.5

[a]Final % body fat as predicted by K^{40}.

[b]Carcass weight, pounds.

[c]Dressing % = cold carcass wt/live wt.

[d]Carcass fat thickness at 12th rib.

[e]% Kidney, pelvic and heart fat.

[f]Rib eye area at 12th rib.

[g]Yield grade.

[h]Quality grade, USDA, 1973, where 7 = low good, 8 = average good, 9 = high good, 10 = low choice, etc.

Large Round Bale Handling

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This report pertains to the analysis of large round bale handling systems begun at the Cornett Farm in 1976. The objective of this research is to analyze various systems for handling 1,200-1,500 pound large round bales. Different system capacities and labor requirements are being determined. This information will be used to develop comparative economic data for the systems studied. A secondary objective is to gain a more thorough understanding of factors such as operator convenience or fatigue, which do not affect system economics but possibly influence farmer preference for one system over another. Five systems are being studied. These are the 3-point hitch fork on the rear of a tractor, 3-point hitch fork on the rear of a 4-wheel drive pickup, a 3-point hitch fork and front end loader on a tractor and 4 and 5 bale automatic bale haulers.

Information gathered consists of:

1. Time required to load bales in the field.
2. Average transport speed--both in field and on the road.
3. Time required to unload and orient bales at the storage site.
4. Documentation of operator comments and observations on systems logistics.

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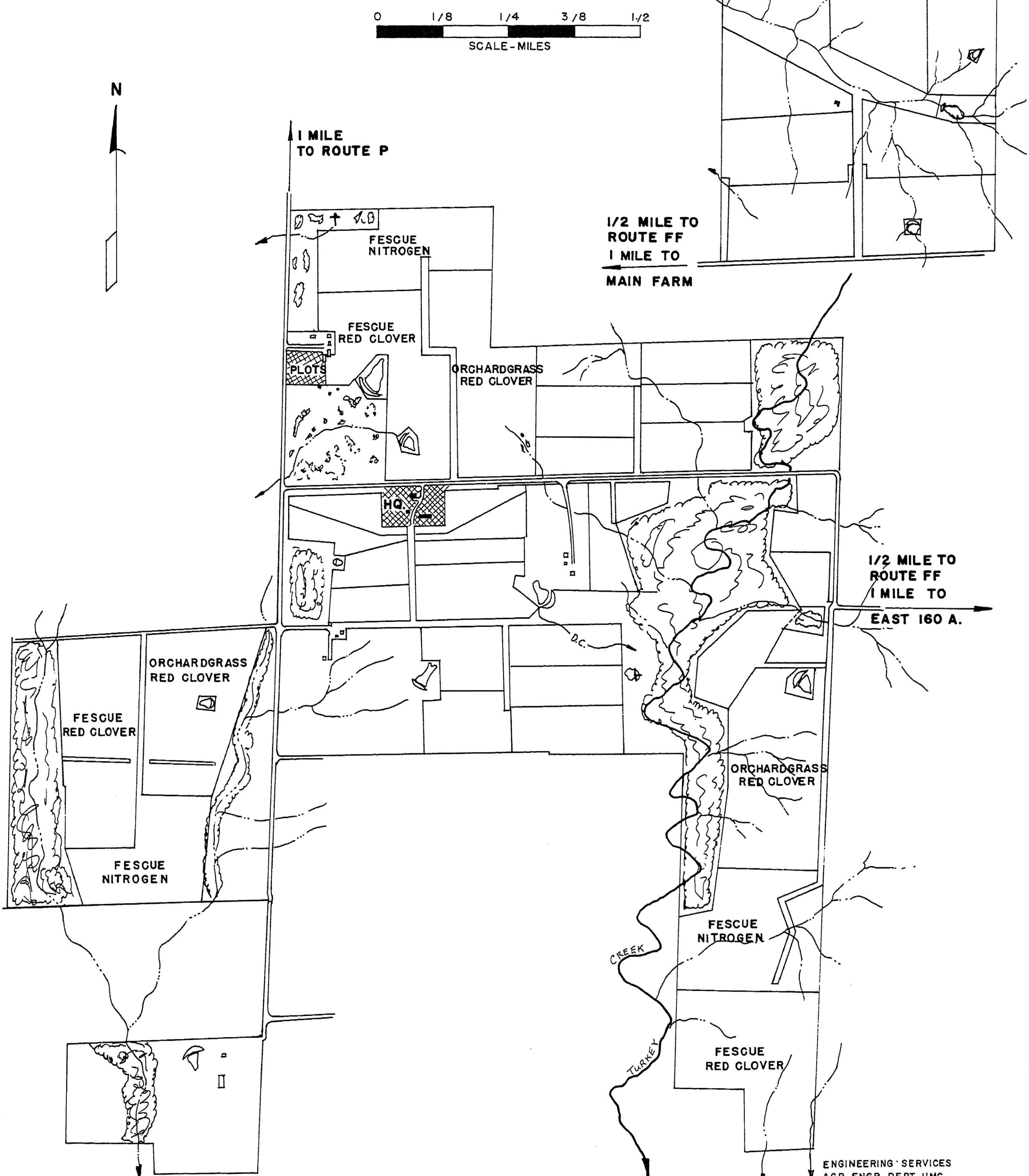
LINNEUS, MISSOURI



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Future Research Plans for the Forage Systems Research Center

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Science moves, but slowly, slowly
Creeping from point to point.

Tennyson

Research always seem to move slower than most of us desire; even when advance planning has been well carried out. In research carried-out here at the Forage Systems Research Center, we must blend (or compromise) the needs and desires of the animal scientist, forage scientist, economist, etc. and the needs of Missouri producers in long range plans. Such plans are now being put into action which will allow the collection of data to start in 1981. At least a three year duration will be necessary. Thus, we are committing the bulk of the resource available for this Center until 1984. Renovation of pastures and changes in herd characteristic have already begun. We hope you will follow the development and results of the proposed research described in the next few pages.

Research Outline

for Forage Systems Research Center

(Part A)

Title: Interaction of steer performance vs. cow types with forage quality before grazing.

Justification:

Animal variation in weight, frame score, maturity type and body composition may influence forage requirements optimum for cow-calf production. Likewise, we need to know whether factors can be developed for converting grazing responses for one class of livestock to another (i.e., steer data to cow-calf performance). This would allow projection of research findings to several classes of livestock and might negate the need for conducting certain types of grazing experiments with more than one class of livestock. This would also provide the basis on which to reinterpret past grazing trial data for different classes of livestock. Development of conversion factors would be useful in modeling of forage-livestock systems.

Objectives:

1. To determine the interaction of cow type with forage quality.
2. To develop animal conversion factors for steers vs. cow-calf performance.
3. To determine the productivity of three forage systems.
4. To model forage-livestock production systems.

Treatment Variables:

A. Two cow types based on body weight, frame score, maturity type and body composition.
B. Steers vs. spring calving cows.
C. Three forage systems

Spring-thru-fall pasture (three areas on map S.W., S.E. and North of HQ Complex)

1. High quality: 'Hallmark' orchardgrass + 'Kenstar' red clover
2. Medium quality: 'Ky-31' tall fescue + 'Kenstar' red clover
3. Low quality: 'Ky-31' tall fescue fertilized annually with 100 lb N/A

Common Winter pasture (Area on maps South of HQ Complex)
'Ky-31' tall fescue + 'Kenstar' red clover.
(The first growth will be put in large round bales and the regrowth accumulated for winter grazing. Round bales will be fed back in feeders during the winter).

Procedures (Abbreviated version):

These replications of pastures will be arranged in an appropriate experimental design after consultation with the Experiment Station statisticians.

Spring-fall pastures will be grazed from about April 15 to September 15, rested until November 1, and then regrowth grazed off, on or before January 1. Cattle will graze winter pastures from September 15 to November 1 while the spring-summer pastures are rested in the fall. After fall regrowth is grazed off between November and January, cows will move back into the winter pastures.

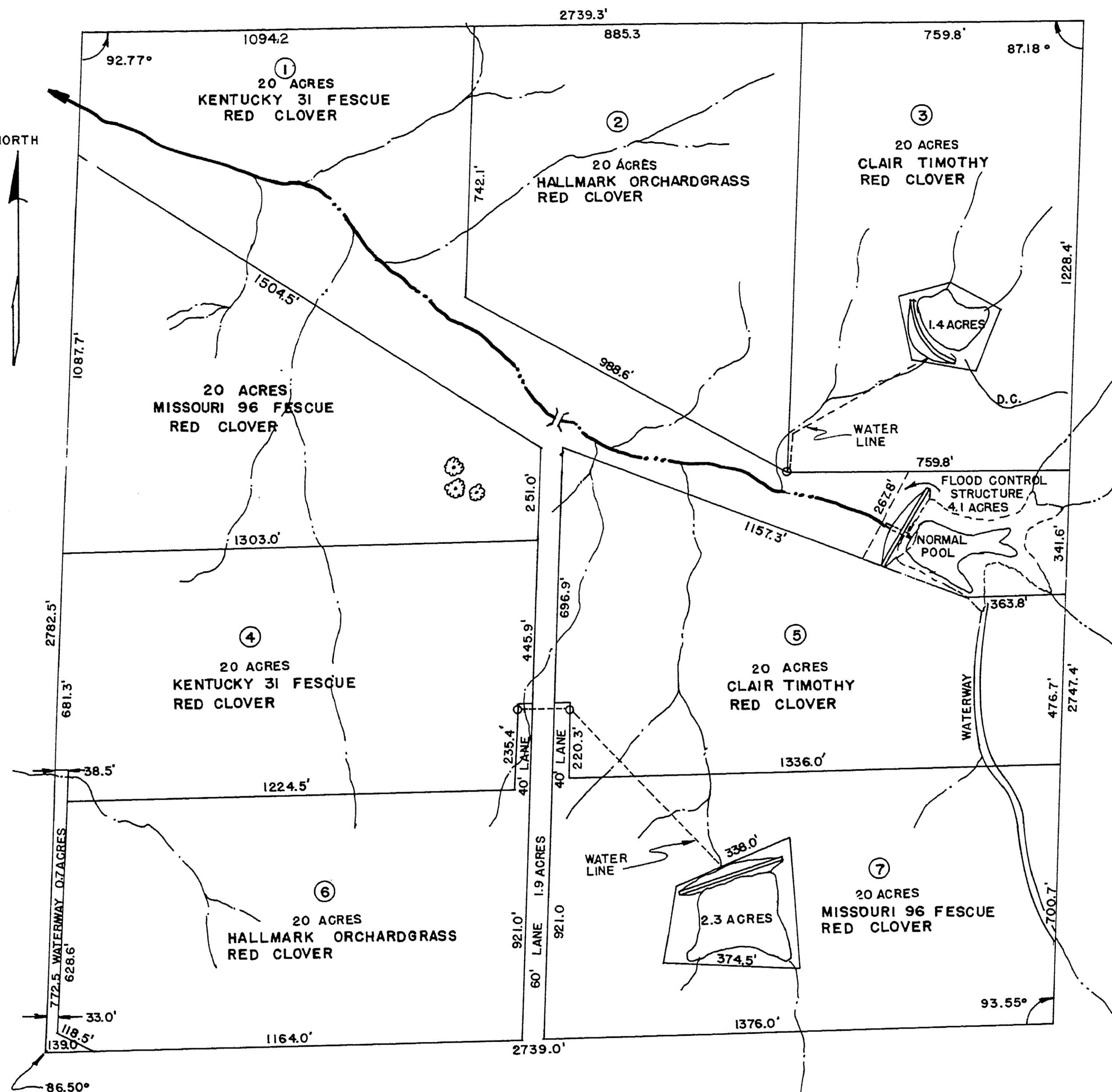
Spring-fall pastures will be grazed in a 3- or 4-paddock rotation. Electric fences will be used to limit area grazed on winter pastures so as to fully utilize stockpiled growth within each increment over a two-week period. Appropriate grazing pressures for the species involved will be maintained by using put-and-take cattle, regulating the area grazed, or by harvesting excess herbage.

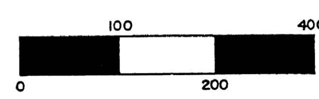
Steers will be from the FSRC herd and from a single backgrounding treatment. Steers will graze spring-fall pastures from April 15 to September 15 and then will be sold off of pasture or carried on into feeding trials and then sold.

Detailed measurements will be made of the sward (i.e., forage availability, botanical composition, stand frequency with point quadrat, mineral composition, cell wall constitutents, IVDMD, etc.)

Also, emphasis will be placed on describing the quality and yield of forage periodically in terms of _in vivo_ intake and digestibility.

Body composition of all or selected tester cattle will be determined in the whole body counter at the start and end of the spring-fall and winter grazing cycles. Shrunk cattle weights will be taken at 28-day intervals throughout the year. Milk production of tester cows will be determined at appropriate times of the year. Reproductive performance information will be maintained on all tester cows.





AREA	ACRES
WATERWAY	0.7
60 X 1366.9 LANE	1.9
PONDS	3.7
FLOOD CONTROL STRUCTURE	4.1
PASTURES (20 ACRE)	160.0
PASTURE (RESERVE)	3.2
TOTAL	173.6

RESEARCH FIELDS, EAST ALLEN PLACE, FORAGE SYSTEMS RESEARCH CENTER, LINNEUS, MO.

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(Part B)

Title: Comparison of forage systems in backgrounding calves, the measurement of carry-over effect of previous forage system and gains related to maturity-type of dam.

Justification:

Calves at weaning are destined for the feed-lot, backgrounding and then the feed-lot or finishing on grass (forage). Knowledge of interaction between maturity-types, previous nutritional status and the quality of forage during the background phase is needed so that a determination of a "most effective forage system" can be devised for cattlemen choosing to background their calves.

The experiment will provide data for input into a modeling study and also serve for on-ground testing of predictive equation derived from the modeling program.

A new fescue variety MO-96 (soon to be released) plus clover will be tested with steers in both grazing and hay feeding periods for comparison with Orchard grass-clover, timothy-clover and Ky 31 fescue-clover. In addition, all tester steers in the main experiment (part A) will have had uniform background and MO-96 will be field tested in a second location in Missouri.

Objectives:

1. To determine the relative ranking of three forage systems on gain of fall weaned calves.
2. To determine the relative nutritional needs of calves from dams of differing maturity types.
3. To complete life cycle of females who will return to the herd as production cows with known nutritional histories.

4. To provide feed-lot steers of known nutritional background and maturity type.
5. To provide input data for modeling and on-ground testing of predictive equation developed in the modeling program.
6. To test productivity of MO-96 fescue-clover in a large field (40A) both by grazing animal and animal performance on the hay produced in comparison to other grass-clover test systems.

Treatments: A. Heifers and steers from 2 maturity type cows.

B. 4 forage systems.

C. Fall grazing - Winter hay feeding - Spring grazing periods.

Forage System: (Note the locations on the maps of East Allen Place, Forage System Research Center)

"Hallmark"	Orchard grass	+	"Kenstar" Red Clover
KY 31	fescue	+	"Kenstar" Red Clover
MO-96	fescue	+	"Kenstar" Red Clover
Clara Timothy		+	"Kenstar" Red Clover

Procedure (abbreviated version): Heifer calves from the main experiment will be weaned, weighed and allotted to one of four forage systems based on dam's maturity background followed by random assignment. This will occur September 1. Steers will be pooled and placed on the MO-96-clover. All animals will be weighed every 28 days. The fall grazing period will be of 100 days duration. Both steers and heifers will be moved to near the Headquarters Building and placed in grazed fescue-clover pastures as holding pens while being fed bailed hay harvested from their assigned fall pastures. The spring grazing period will be by necessity short. Heifers to be removed from their respective treatment pasture early enough to not seriously affect the hay yield. The rest of the assigned pasture (1/2) will not be grazed until late summer. Heifers for replacement will be chosen and the remainder will be available for other experiments or sold. Steers will be assigned from the winter phase to become testers for the main experiment. The MO-96-clover spring growth will be used as hay.

Grazing pressure and measurements of the sward will be done as outlined in the main experiment.

(Part C)

Title: Plots in support of forage-livestock systems research.

Location: (Main FSRC map) to the N.W. of HQ complex marked plots.

Effort: Birdsfoot Trefoil seed production plot now in first year.

Effort: Disease resistance in Orchard Grass now in planning stage.

Effort: Cool season grass production under different clipping and fertility practices to correlate with data being collected at the Southwest Res. Center, Mt. Vernon, Mo. and at the Bradford Farm, Columbia, Mo. now in planning stage. They would be newly released varieties or introductions of promise which might have a place in Missouri's forage-livestock scene.

The research and Center management decisions are carried out by a FSRC Management Committee. Committee members are: David Currence, ag. engineering; Ron Morrow, animal husbandry; Fred Martz, dairy husbandry; A. G. Matches, agronomy; Jim Huggans, entomology; George Garner, biochemistry; Jim Stricker, and John Shelburne, FSRC.

Special acknowledgement is given to John White, ag. engineering services, for Center lay-out and maps.