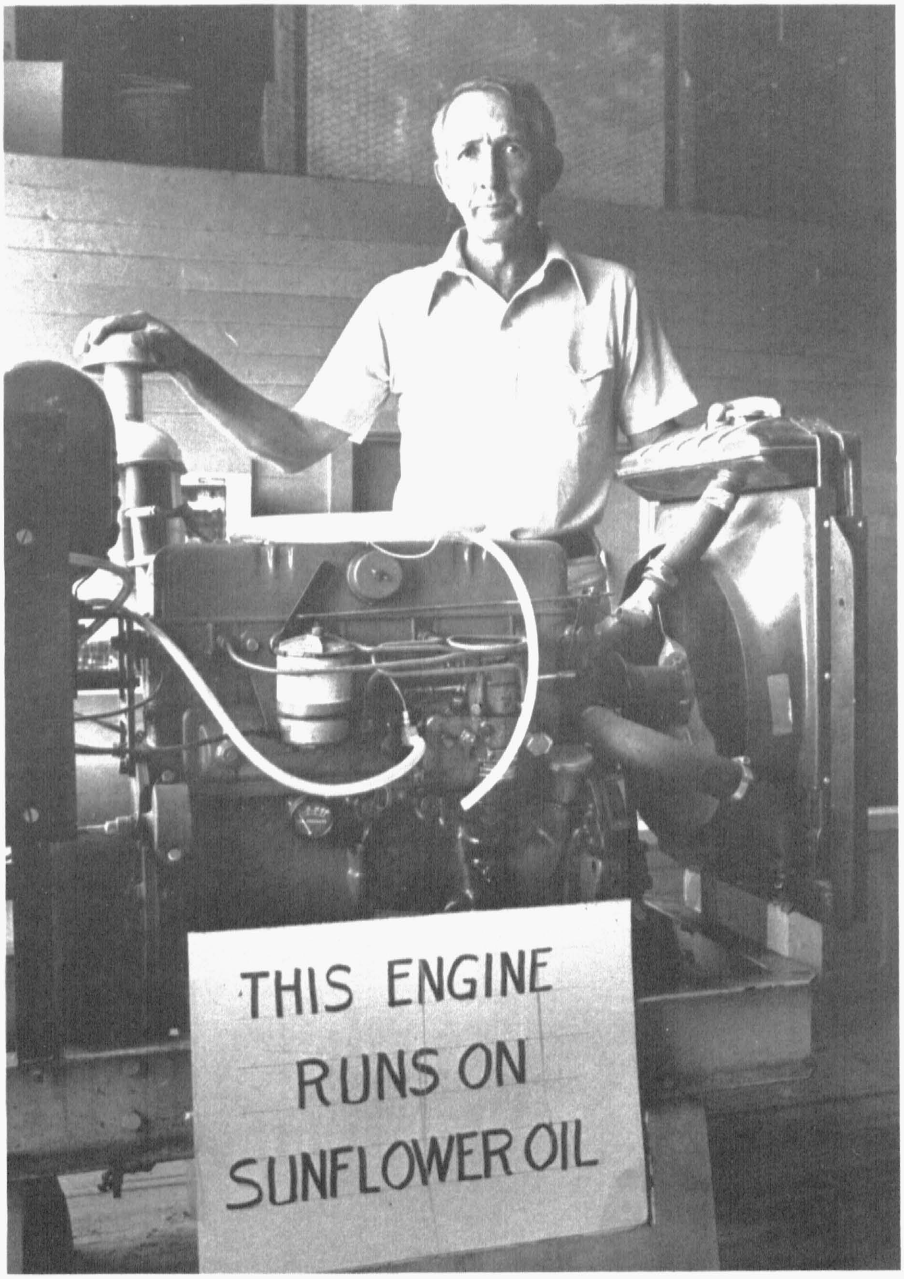
1980 Research Report



Southwest Missouri Center

Mt. Vernon

Special Report 250
College of Agriculture
University of Missouri-Columbia

UNIVERSITY OF MISSOURI-COLUMBIA
Science in the Public Service

College of Agriculture

Agricultural Experiment Station
SOUTHWEST MISSOURI CENTER
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September 19, 1980

Welcome:

You are invited to read and study this research report. We welcome your suggestions. You are also invited to visit the Center often and observe the research in progress. The Center belongs to the people of this area and its progress depends on your continued interest and support. Agricultural research is our primary endeavor but the Center is also active in other areas. Agriculture Education is one example. The Center was host to more than 2,000 FFA students who used it as an outdoor laboratory during the past year.

The Extension Division continues to offer many educational programs for all age groups. You are invited to take part in these and other programs held at the Center throughout the year. We have an "open door" policy and visitors are always welcome.

There was a combined attendance of more than 7,000 visitors and participants at Center activities last year. In addition, Center personnel spoke to 35 off-Center groups.

Come see us!

Sincerely yours,

Norman

Norman Justus
Superintendent

SOUTHWEST MISSOURI CENTER[1]

Farmers and businessmen worked closely with the College in the establishment of the Southwest Center near Mount Vernon. A limited program of research in soil fertility and field crops has been conducted on a small piece of land near Pierce City for a number of years.

Most of the farms in the area are relatively small and the level of soil fertility is generally low. Several years with below normal rainfall were climaxed with a severe drouth in 1954. Many farmers were in serious financial trouble and a number of them abandoned their farms. The economy of the entire area was affected adversely and business and industrial people, who realized the importance of agriculture in the area, were interested in the establishment of an agricultural research program in the area.

The problems of the area were discussed by farm people and business people and by groups composed of rural and urban representatives. Agricultural college staff members participated in the discussions. From the discussions the belief emerged that an agricultural research center, which would conduct investigations of the problems of the area, would develop valuable information which would help solve some of the major problems. An areawide committee with a representative from each of the 22 counties was formed, with Mills H. Anderson, a Carthage banker, as chairman. The committee requested the Agricultural Experiment Station to develop a research program for the area.

The director of the Experiment Station appointed a committee of College staff members January 23, 1957, and directed the committee to develop a research proposal and to consider the establishment of a research center in the area. The committee moved rapidly and submitted the proposed plan, which was approved by the director. The Board of Curators approved the proposal and a bill was introduced in the General Assembly providing for the establishment of a research center in southwest Missouri. The bill was passed and became law July 6, 1957.

The Board of Curators included in the University appropriations request for fiscal 1958-59 the amount of $75,000 for the purchase of land. The amount requested was approved by the General Assembly.

On May 2, 1958, the director appointed a committee of staff members to conduct a search for a suitable location for the center and make recommendations to the director. The site selection committee established criteria to be used in making the selection. More than 50 suggested farms were proposed and members of the committee inspected about 25 of them. Two farms lying on opposite sides of Highway 166, about 2.5 miles southwest of Mount Vernon were chosen as the most desirable location. The two farms had a total of 590 acres and were bought for $70,000. The Southwest Research Center was officially dedicated November 5, 1959.

The General Assembly has appropriated funds to pay for necessary building, facilities, equipment, and operations. A comprehensive research program has been developed and results of value to the agriculture of the area are being obtained.

Since 1965 three adjoining tracts totalling 308 acres have been bought and included in the area.

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[1]This information was taken from THE CENTENNIAL REPORT--1870-1970--OF THE COLLEGE OF AGRICULTURE, written by Dr. John H. Longwell, dean emeritus of the College.

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MANAGEMENT OF CAUCASIAN

BLUESTEM IN PASTURE SYSTEMS

A.G. Matches, USDA, SEA, Agricultural Research and
Department of Agronomy
S. Bell and D. Mowery, Southwest Center
F.A. Martz, Dairy Husbandry Department

Abstract. Pasture-System grazing experiments at the Southwest Center are being revised to determine the optimum management of Caucasian bluestem. Details and scope of this research are discussed below. Grazing began in the spring of 1980.

Objectives: To determine the optimum pattern of management and utilization for caucasian bluestem in pasture systems with tall fescue-red clover.

Research Approach: Pastures of 'Ky-31' tall fescue-red clover mixture are paired with pastures of caucasian bluestem for grazing in pasture systems designed to furnish summer forage. Research recently completed indicates that caucasian bluestem provides an abundance of herbage from June into August or early September and may have good fall regrowth to provide grazing again in October. Generally, the forage quality of caucasian bluestem is medium to low, averaging around 50% IVDMD and 5 to 10% crude protein. Laboratory data indicate that its crude protein levels may be insufficient to maintain rumen microflora activity.

Other experiments we have conducted show that birdsfoot trefoil and red clover are legumes that may survive with caucasian bluestem under grazing. Because of its high growth rate in spring, we have experienced difficulties in fully utilizing effectively the first growth of bluestem under grazing. With this background, the following treatments are being imposed on caucasian bluestem:

(1) Caucasian bluestem rotationally grazed in a 2- or 3-paddock rotation.

(2) Caucasian bluestem with two paddocks rotationally grazed and one paddock harvested as hay, round-baled, and the regrowth + round bales grazed in late summer.

(3) Caucasian bluestem-red clover mixture rotationally grazed in a 2- or 3-paddock rotation.

(4) Caucasian bluestem-birdsfoot trefoil mixture rotationally grazed in a 2- or 3-paddock rotation.

(5) Caucasian bluestem rotationally grazed in a 2- or 3-paddock rotation plus protein supplement fed to cattle.

Established pastures of 'Kentucky-31' tall fescue were overseeded with red clover in March 1980. The caucasian bluestem was seeded in June 1979 and red clover and birdsfoot trefoil overseeded in February 1980. Good stands of grass and legumes were obtained in nearly all pastures. Grazing of this experiment began in April 1980, and results will be reported in the Research Report next year.

LEGUMES FROST-SEEDED INTO SODS OF

SWITCHGRASS AND CAUCASIAN BLUESTEM

A.G. Matches, USDA,SEA, Agricultural Research and Department of Agronomy
D. Mowery, Southwest Center

Abstract: We have concerns about the high cost of nitrogen fertilizer and the low quality of some warmseason grasses at times during the growing season. Therefore, experiments were initiated in 1976 to frost-seed legumes into established stands of warmseason grasses.

Five legumes were frost-seeded into old stands of 'Pathfinder' switchgrass and caucasian bluestem during March of 1976 and 1977. 'Dawn' and 'Cascade' birdsfoot trefoil and 'Kenstar' red clover were successfully established, but stands of alfalfa and ladino clover were quite variable. Forage yields (average of 3 years) of the grasses grown alone ranged from 3852 to 5954 lb. of dry matter per acre as compared to yields of 6966 to 9721 lb. per acre for the warmseason grasses grown with red clover or birdsfoot trefoil. Red clover and 'Cascade' trefoil tended to smother out switchgrass when cut at a hay stage of growth.

Our results show that: (a) certain legumes can be successfully established into sods of switchgrass and caucasian bluestem, (b) legumes result in higher forage yields and give a better seasonal distribution of forage production than these grasses grown alone without nitrogen fertilization, (c) the growth canopy of legumes should be removed frequently to prevent shading injury and loss of grass stands, and (d) legumes increase the digestibility of the forage from 2 to 12 percentage units.

Earlier research (see report on Growing Legumes with Warm-Season Grasses in the 1976 Southwest Center Research Report) indicated that certain legumes are adapted for growing in mixtures with caucasian bluestem and switchgrass. This experiment is an expansion of the previous research.

In this experiment, five legumes were frost seeded into old established stands of caucasian bluestem and 'Pathfinder' switchgrass. Prior to seeding, the area was fertilized with 0-60-90 fertilizer and lightly disked. On March 15, 1976, and March 23, 1977, legumes were distributed with a cultipacker seeder. The legumes seeded were:

Treatment	Legume
A	'Dawn' Birdsfoot Trefoil
B	'Cascade' Birdsfoot Trefoil
C	'Victoria' Alfalfa
D	'Kenstar' Red Clover
E	'Arcardia' Ladino Clover

Table 1. Average total yield of forage for 'Pathfinder' switchgrass and caucasian bluestem grown alone and with legumes in 1977-'79.

Interseeded Legumes	Total Yield of Dry Matter (3 yr. avg.) Management System			
	Hay		Pasture	
	Switchgrass	Bluestem	Switchgrass	Bluestem
	lb/A			
Dawn Trefoil	8339	8950	6966	8628
Cascade Trefoil	8960	9721	7574	9142
Victoria Alfalfa	6638	6415	5641	5240
Kenstar Red Clover	8296	9041	7520	8644
Arcadia Ladino Clover	6228	6098	5848	7198
Grass Alone	5954	4954	4463	3852
Average	7402	7530	6335	7117
Maximum Increase from Legumes	3006	4767	3111	5290

Table 2. Percent legume with caucasian bluestem on two sampling dates in 1979[1].

Interseeded Legumes	% legume			
	Pasture		Hay	
	May 10	Sept 17	May 31	Aug 21
Dawn Trefoil	84	64	77	31
Cascade Trefoil	72	47	85	72
Victoria Alfalfa	26	22	63	16
Kenstar Red Clover	31	27	60	33
Arcadia Ladino Clover	36	19	18	9
Average	50	36	61	33

[1] Percent legume obtained by hand separation of forage and reported on a dry matter basis.

A sixth treatment (F) was grass grown alone.

All legumes except alfalfa were successfully established from the 1976 frost seedings. Poor legume stands were obtained from the March 1977 seeding; but by the fall of 1978, the birdsfoot trefoil, ladino clover, and red clover stands were greatly improved.

Plots overseeded in 1976 were harvested as follows: (1) harvested on a hay-cutting schedule, and (2) harvested on a simulated pasture grazing schedule. Hay plots were harvested whenever the legume reached 1/10 bloom or the grass reached the late-boot to early-heading stage of development. Pasture harvests were taken at 4- to 6-week intervals beginning when grass or legume growth reached a height of 10 to 18 inches.

Results: Total yields of dry matter (average for 1977-79) for switchgrass and caucasian bluestem grown alone and with legumes are shown in Table 1. With both warm-season grasses, total yields were often times over 100% higher with 'Kenstar' red clover and 'Cascade' and 'Dawn' birdsfoot trefoil as compared to growing the grasses alone and without nitrogen fertilizer. Maximum yield increases with legumes ranged from 3006 to 5290 lb. of dry matter per acre.

Even in the third year of harvesting, stands of both trefoils were excellent (Tables 2 and 3). Red clover was reseeded after the second year (February 1979) and still contributed nearly as much to the botanical composition of forage as did the trefoils in 1979. Stands of alfalfa and ladino clover ranged from poor to fair and did not contribute as much to yields as did the excellent stands of birdsfoot trefoil and red clover.

Under a hay-management system, it appears that red clover and birdsfoot trefoil may cause reduction in stands of the warm-season grasses because of shading from the canopy of legumes. Grass stands remained excellent under the frequent defoliation to simulate pasture conditions.

Digestibility (IVDMD) of forage was determined in the laboratory using *in vitro* techniques. Digestibilities for each harvest in 1979 are given in Tables 4, 5, 6 and 7. In nearly every harvest, growing a legume with the warmseason grasses increased the digestiblity of the forage. Average increases in digestibility ranged from 2 to 12 percentage units above digestibility of the grass alone. Legumes were especially beneficial during the months which normally have hot weather (June-August).

These experiments will be terminated following a residual harvest in the spring of 1980.

Table 3. Percent legumes with 'Pathfinder' switchgrass on two sampling dates in 1979.[1/]

Interseeded Legumes	% legume			
	Pasture		Hay	
	May 10	Sept 17	May 31	Aug 21
Dawn Trefoil	58	47	55	52
Cascade Trefoil	65	38	79	92
Victoria Alfalfa	24	20	18	13
Kenstar Red Clover	44	38	66	51
Arcadia Ladino Clover	48	47	35	51
Average	48	38	51	51

1/ Percent legume obtained by hand separation of forage and reported on a dry matter basis.

Table 4. Digestibility (IVDMD) trends for caucasian bluestem alone and interseeded with legumes when harvested as hay in 1979.

Interseeded Legume	% IVDMD			
	Harvest Dates - 1979			
	May 31	July 10	Aug 21	Nov 10
Dawn Trefoil	60	61	56	48
Cascade Trefoil	60	57	58	54
Victoria Alfalfa	62	54	56	50
Kenstar Red Clover	57	59	57	52
Arcadia Ladino Clover	60	51	49	43
Grass Alone	57	48	48	41
Average[1/]	60	56	55	49

1/ Average for grass-legume mixtures.

Table 5. Digestibility (IVDMD) trends for caucasian bluestem alone and with interseeded legumes when sampled as simulated pasture in 1979.

Interseeded Legume	% IVDMD Harvest Dates - 1979 May 10	June 20	July 20	Sept 17	Nov 11
Dawn Trefoil	67	60	60	43	39
Cascade Trefoil	65	59	56	46	45
Victoria Alfalfa	59	55	50	48	52
Kenstar Red Clover	61	54	52	44	45
Arcadia Ladino Clover	63	60	57	46	42
Grass alone	56	49	44	41	43
Average[1/]	63	58	55	45	45

[1/] Average for grass-legume mixture.

Table 6. Digestibility (IVDMD) trends for 'Pathfinder' switchgrass alone and interseeded with legumes when harvested as hay in 1979.

Interseeded Legume	% IVDMD Harvest Dates - 1979 May 31	July 10	Aug 21	Nov 10
Dawn Trefoil	58	62	61	57
Cascade Trefoil	55	56	57	54
Victoria Alfalfa	61	63	60	55
Kenstar Red Clover	52	59	55	54
Arcadia Ladino Clover	58	68	63	55
Grass Alone	55	58	56	51
Average[1/]	57	62	59	55

[1/] Average for grass-legume mixtures.

Table 7. Digestibility (IVDMD) trends for 'Pathfinder' switchgrass alone and interseeded with legumes when harvested as simulated pasture in 1979.

Interseeded Legume	% IVDMD Harvest Dates - 1979 May 10	June 20	July 20	Sept 17	Nov 11
Dawn Trefoil	69	62	66	58	56
Cascade Trefoil	66	61	60	58	55
Victoria Alfalfa	70	59	64	54	58
Kenstar Red Clover	65	60	63	53	58
Arcadia Ladino Clover	70	70	70	62	62
Grass alone	64	57	60	51	47
Average[1/]	68	62	65	57	58

[1/] Average for grass-legume mixtures.

MANAGEMENT OF TALL FESCUE CULTIVARS

GROWN WITH LEGUMES

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Abstract. Eight tall fescue cultivars (five experimentals and three released cultivars) were seeded alone, with 'Kenstar' red clover and with 'Empire' birdsfoot trefoil on September 20, 1977. Plots were harvested as hay and as simulated pasture. In 1979, the second harvest year, forage yields averaged 6815 and 8558 lb/A for the pasture and hay management systems. Yields were higher for fescue seeded with trefoil than when fescue was grown alone and fertilized with 125 lb nitrogen per acre. Yields of fescue and red clover also exceeded yield of fescue alone in the hay management system. Legumes helped maintain a more even seasonal distribution of forage production.

Objectives: To compare and determine the compatibility of new tall fescue cultivars with legumes under hay and simulated pasture cutting systems.

Research Approach: Eight cultivars of tall fescue were seeded alone, with 'Empire' birdsfoot trefoil, and with 'Kenstar' red clover at the Southwest Center on September 20, 1977. Cultivars of tall fescue seeded are:

MO96 H-1 H-2 WG-2B WG-3B	From the University of Missouri grass breeding program.
5-402 Kenhy	From the USDA, SEA, AR breeding program at Lexington, KY.
Ky 31	

Management treatments consist of harvesting (1) at a hay stage of development or (2) to simulate the grazing of pastures (harvested more frequently than hay management treatments). A fall growth residual harvest is taken from all plots in late October or early November. The experimental design is a split-split-plot with grass alone or with legumes as whole-plots, cutting management as sub-plots, and tall fescue cultivars as sub-sub-plots. There are three replications.

Tall fescue grown alone is fertilized with 75 lb nitrogen/A in February or March and another 50 lb N/A in August. The fescue + legume combinations are not fertilized with nitrogen. All plots annually receive a broadcast application of 30 lb P_2O_5 and 60 lb K_2O/A during February or early March.

Results for 1979: Overall, total yields of dry matter were highest in the hay management system (Table 1). In the simulated pasture system, greatest yields were obtained with the fescue + trefoil mixture, followed by fescue alone, and lowest yields were obtained with the fescue + red clover mixture. This was the second year of harvesting, and red clover stands had begun to decline; this may have accounted for the low production from fescue + red clover.

However, in the hay management system, fescue + red clover yielded the most, followed next by fescue + trefoil, and the lowest yielding was fescue alone. Stands of red clover in July in the hay management plots were nearly double the red clover stands in the pasture plots.

Some spread in yield among the tall fescue cultivars is beginning to become evident; however, cultivars differed significantly only in the case of fescue + trefoil harvested as hay. The maximum spread in total yield for fescue cultivars grown alone was 995 and 1321 lb/A for the pasture and hay harvests, respectively. With the fescue-legume mixtures, maximum yield differences for fescue + red clover and fescue + trefoil, respectively, were 1440 and 1084 lb/A in the pasture harvests and 1436 and 1939 lb/A for the hay harvests. Although stand data is not presented here, there did not appear to be large differences in the amount of legumes present among plots of different fescue cultivars.

Seasonal trends in forage production are given in Tables 2 through 7. Legumes helped sustain higher forage production during the summer months, and this resulted in a more even supply of forage over the growing season.

Digestibility (IVDMD) of forage from each harvest was determined in the laboratory. The results (Tables 8 through 13) were not as explicit as we had expected. Perhaps most noteworthy is the digestibility of 62% or above for fescue + trefoil throughout most of the growing season when cut as simulated pasture. This experiment will be continued through the 1981 growing season.

Table 1. Total yield of dry matter in 1979 from the tall fescue management experiment. (TFM-SWC)

Tall Fescue Cultivars	Total Yield of Dry Matter (lb/A)					
	Pasture Management			Hay Management		
	Fescue Alone	With Red Clover	With Trefoil	Fescue Alone	With Red Clover	With Trefoil
MO 96	5532	5507	7782	8205	9789	8845
H-1	6141	5426	7734	7779	9682	8262
5-402	6361	6743	7919	7369	9491	9740
WG-3B	6690	5351	7633	7499	8352	8959
Kenhy	6630	6249	7964	8068	9397	8627
H-2	7194	5670	8717	6884	9543	8704
WG-2B	6486	6791	7894	7332	9519	8637
Ky 31	6454	6082	8600	7932	8973	7801
Average	6436	5977	8033	7633	9342	8697
least significant difference (.05)	not significant	n.s.	n.s.	n.s.	n.s.	1421
coefficient of variance	9.9%	18.0%	7.3%	13.5%	17.4%	6.6%

Table 2. Seasonal yield trends for tall fescue harvested on a hay cutting schedule.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates - 1979 May 24	July 9	Aug 28	Nov 6	Total Yield
Mo 96	5873	1037	933	362	8205
H-1	5961	988	512	318	7779
5-402	5599	913	537	320	7369
WG-3B	5068	1010	826	595	7499
Kenhy	5928	1078	634	428	8068
H-2	4514	1330	673	367	6884
WG-2B	5114	1160	594	464	7332
Ky 31	5979	988	598	367	7932
Average	5504	1063	663	403	7633

Table 3. Seasonal yield trends for tall fescue + red clover harvested on a hay cutting schedule.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates - 1979 May 24	July 9	Aug 28	Nov 6	Total Yield
Mo 96	4187	2936	1999	667	9789
H-1	4247	2998	1780	657	9682
5-402	4030	2726	2189	546	9491
WG-3B	3645	2138	1896	673	8352
Kenhy	4056	2618	2086	637	9397
H-2	4096	2618	2154	675	9543
WG-2B	4651	2577	1659	632	9519
Ky 31	4337	2328	1712	596	8973
Average	4156	2617	1934	635	9342

Table 4. Seasonal yield trends for tall fescue + birdsfoot trefoil harvested on a hay cutting schedule.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates - 1979				
	May 24	July 9	Aug 28	Nov 6	Total Yield
Mo 96	4105	2703	1624	413	8845
H-1	3873	2485	1471	433	8262
5-402	4333	3471	1558	378	9740
WG-3B	3600	2821	1879	659	8959
Kenhy	3478	2881	1786	482	8627
H-2	4098	2739	1346	521	8704
WG-2B	3879	2839	1496	423	8637
Ky 31	3370	2773	1275	383	7801
Average	3842	2839	1554	462	8697

Table 5. Seasonal yield trends for tall fescue harvested as simulated pasture.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates					
	May 7	June 21	July 18	Sept 21	Nov 6	Total Yield
Mo 96	2556	1909	365	500	202	5532
H-1	3179	1794	419	502	247	6141
5-402	3358	1975	345	478	205	6361
WG-3B	3001	2170	459	652	408	6690
Kenhy	2857	2264	525	730	254	6630
H-2	2818	2979	522	624	251	7194
WG-2B	3189	2062	453	566	216	6486
Ky 31	3119	2101	387	630	217	6454
Average	3010	2157	434	585	250	6436

Table 6. Seasonal yield trends for tall fescue + red clover harvested as simulated pasture.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates May 7	June 21	July 18	Sept 21	Nov 6	Total Yield
Mo 96	1531	1049	1072	1661	194	5507
H-1	1961	933	873	1474	185	5426
5-402	2537	1065	952	1919	270	6743
WG-3B	1779	917	816	1554	285	5351
Kenhy	2004	1033	1081	1906	225	6249
H-2	1871	982	950	1694	173	5670
WG-2B	2403	1138	1197	1824	229	6791
Ky 31	1924	1236	867	1870	185	6082
Average	2002	1044	976	1738	218	5977

Table 7. Seasonal yield trends for tall fescue + birdsfoot trefoil harvested as simulated pasture.

Tall Fescue Cultivars	Yield of Dry Matter (lbs/A) Harvest Dates May 7	June 21	July 18	Sept 21	Nov 6	Total Yield
Mo 96	2105	2413	955	2154	195	7822
H-1	2107	2147	1107	2023	350	7734
5-402	1918	2884	991	1920	206	7919
WG-3B	2088	2494	893	1858	300	7633
Kenhy	2034	2809	1056	1849	198	7946
H-2	1904	3633	1118	1839	223	8717
WG-2B	2311	2301	1050	1957	275	7894
Ky 31	2484	2456	1072	2328	260	8600
Average	2119	2642	1030	1991	251	8033

Table 8. Digestibility (IVDMD) trends for tall fescue cultivars harvested on a hay cutting schedule in 1979.

Tall Fescue Cultivars	% IVDMD Harvest Dates - 1979[1/] May 24	July 9	Nov 6
Mo-96	60	61	49
H-1	58	61	52
5-402	61	62	53
WG-3B	60	60	51
Kenhy	66	62	50
H-2	59	63	49
WG-2B	59	59	48
Ky 31	61	63	48
Average	60	61	50

[1/] Samples from the August 23 harvest were overheated due to a malfunction of drying ovens; therefore, digestibilities for this date were not accurate.

Table 9. Digestibility (IVDMD) trends for tall fescue + red clover harvested on a hay cutting schedule in 1979.

Tall Fescue Cultivars	% IVDMD Harvest Dates - 1979[1/] May 24	July 9	Nov 6
Mo-96	63	58	54
H-1	63	58	54
5-402	63	56	51
WG-3B	60	56	47
Kenhy	64	58	48
H-2	64	56	48
WG-2B	61	56	46
Ky 31	60	56	50
Average	62	57	50

[1/] Samples from the August 23 harvest were overheated due to a malfunction of drying ovens; therefore, digestibilities for this date were not accurate.

Table 10. Digestibility (IVDMD) trends for tall fescue + birdsfoot trefoil harvested on a hay cutting schedule in 1979.

Tall Fescue Cultivars	% IVDMD Harvest Dates - 1979[1/] May 24	July 9	Nov 6
Mo-96	58	55	58
H-1	55	55	58
5-402	59	56	58
WG-3B	56	53	59
Kenhy	57	56	58
H-2	57	54	59
WG-2B	55	51	58
Ky 31	57	54	57
Average	57	54	58

[1/] Samples from the August 23 harvest were overheated due to a malfunction of drying ovens; therefore, digestibilities for this date were not accurate.

Table 11. Digestibility (IVDMD) trends for tall fescue cultivars harvested as simulated pasture in 1979.

Tall Fescue Cultivars	% IVDMD Harvest Dates in 1979				
	May 7	July 21	Aug 18	Sept 21	Nov 6
Mo-96	60	54	57	58	63
H-1	57	54	56	57	61
5-402	66	55	60	59	64
WG-3B	61	52	56	56	62
Kenhy	64	56	57	58	65
H-2	64	55	56	56	62
WG-2B	62	52	54	54	63
Ky 31	64	54	57	57	64
Average	62	54	57	57	63

Table 12. Digestibility (IVDMD) trends for tall fescue + red clover harvested as simulated pasture in 1979.

Tall Fescue Cultivars	% IVDMD Harvest Dates in 1979				
	May 7	July 21	Aug 18	Sept 21	Nov 6
Mo-96	58	55	60	57	47
H-1	57	55	58	57	55
5-402	62	61	60	58	47
WG-3B	58	56	57	55	45
Kenhy	58	58	60	57	49
H-2	58	58	59	57	49
WG-2B	54	57	58	56	45
Ky 31	57	58	59	57	46
Average	58	57	59	57	48

Table 13. Digestibility (IVDMD) trends for tall fescue + birdsfoot trefoil harvested as simulated pasture in 1979.

Tall Fescue Cultivars	% IVDMD				
	Harvest Dates in 1979				
	May 7	July 21	Aug 18	Sept 21	Nov 6
Mo-96	63	61	66	61	47
H-1	63	61	67	61	47
5-402	68	62	69	64	48
WG-3B	63	61	64	61	46
Kenhy	65	64	68	62	49
H-2	66	62	68	62	46
WG-2B	61	59	67	62	45
Ky 31	64	63	68	62	46
Average	62	54	57	57	63

ORCHARDGRASS AND TALL FESCUE BREEDING

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Abstract: Progeny testing of orchardgrass and tall fescue continues to be conducted at the Southwest Research Center. We have more than 40 synthetics under evaluation. Objectives center around breeding tall fescue and orchardgrass varieties with improved animal performance. Selection has been placed on vigor, disease resistance, maturity, leafiness, drought tolerance, winterhardiness, and forage quality.

Work on orchardgrass involves breeding for resistance to stem rust and the improvement of forage quality. W. Q. Loegering (Plant Pathology) is conducting cooperative research with us on the nature of stem rust resistance in orchardgrass. Histological studies of orchardgrass infected with stem rust were made to determine the effect of this pathogen on digestibility. Two plots of two genotypes of orchardgrass were planted in the field. One plot was inoculated with stem rust and the second kept free of the pathogen by spraying twice a week with a fungicide. Cross sections (12 μ) of leaves from the two plots were subjected to 48 hours digestion in rumen fluid. Figure 1 contains a cross section of an orchardgrass leaf that has no stem rust and has not been digested. Notice that all tissues are intact. Cross sections from the sprayed (healthy) plot showed complete digestion of all tissues except lignified structures (Figure 2), whereas sections from leaves from the inoculated (diseased) plot showed no apparent digestion of tissues in which mycelium was evident (Figure 3) and only partial digestion of tissues in which no mycelium occurred. These results indicate that stem rust of orchardgrass not only reduces forage yield but also adversely affects the quality of the forage.

Breeding for improved forage quality is an important consideration in orchardgrass improvement. Of prime importance is the voluntary intake of the grazing animal and the related quality factors. Voluntary intake is a complex process and is dependent on the animal's characteristics as well as those of the forage. Forage digestibility and fiber content, which are interrelated, have been found to affect voluntary intake.

In vitro dry matter disappearance (IVDMD) and fiber content were closely examined in our orchardgrass breeding materials. Fourteen clones were used as parents and placed into two polycross blocks by maturity. The first polycross block (E1) contained six and the second (E2) eight parental clones that had previously been selected for resistance to leaf diseases.

Mean percent IVDMD, acid detergent fiber (ADF), and neutral detergent fiber (NDF) for E1 and E2 are presented in Table 1. Spring harvest IVDMD values ranged from 59.8 to 63.5%. Mean values in the present study ranged from 32.1 to 35.7% ADF and 55.9 to 62.4% NDF for first harvest orchardgrass, and from 26.1 to 39.1% ADF and 49.0 to 63.7 NDF in the regrowth herbage.

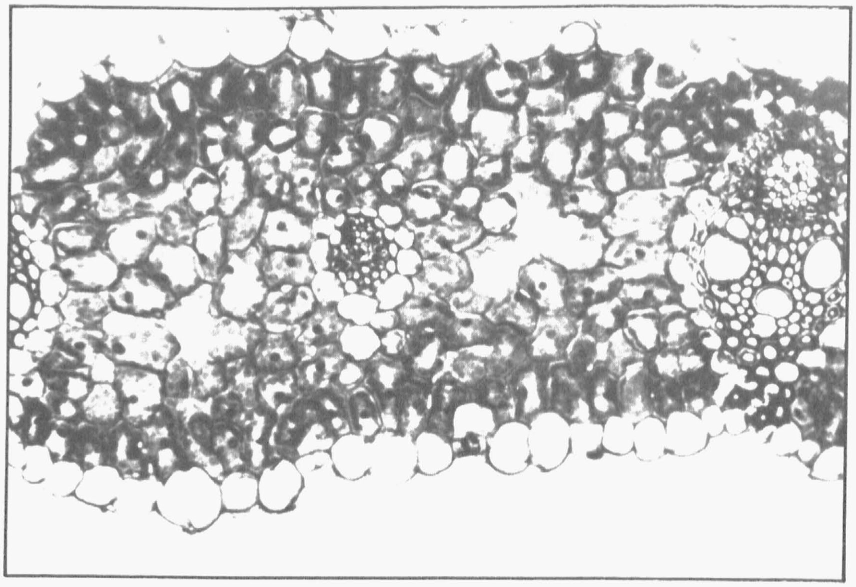


Figure 1. Cross section of a healthy undigested orchardgrass leaf (200x).

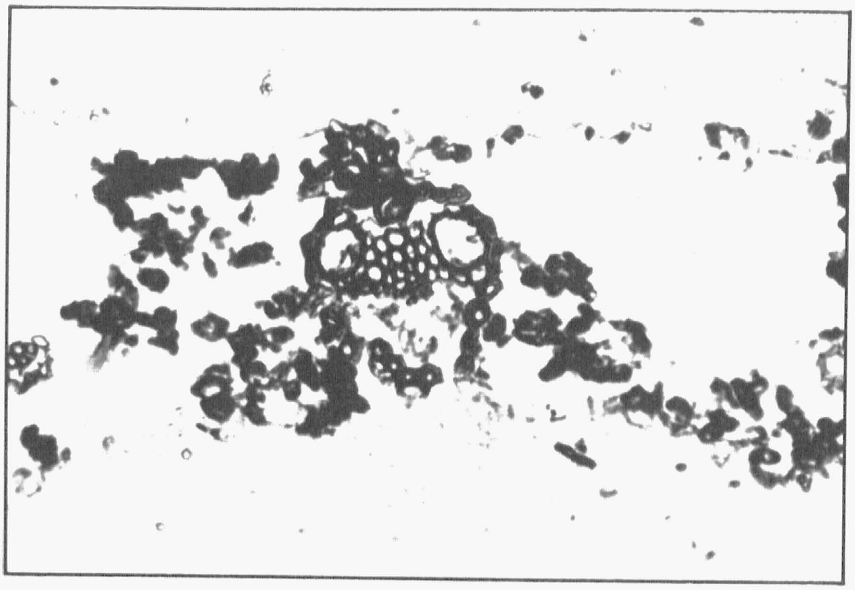


Figure 2. Cross section of a healthy orchardgrass leaf after 48 hours of digestion in rumen fluid (200x).

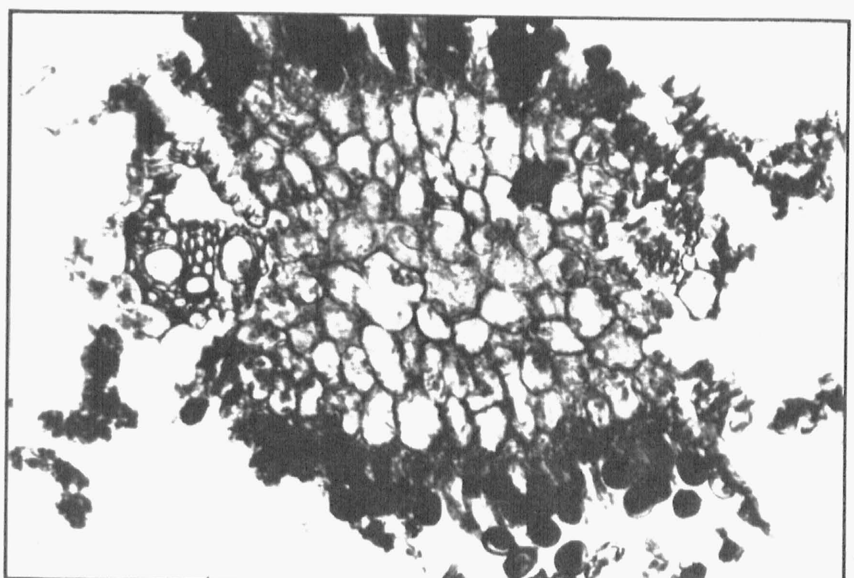


Figure 3. Cross section through a pustule of stem rust in an orchardgrass leaf after 48 hours of digestion. Note lack of digestion (200x).

Dry matter yield, IVDMD, and fiber content differed significantly between harvests. In the first year, IVDMD in both experiments was high at the first harvest date, decreased at second harvest, and increased again at the third harvest. Fiber content, both ADF and NDF, followed the opposite pattern, being highest at second harvest and lower at the first and third harvests. Yield decreased at each successive harvest date.

These patterns were altered somewhat in the second year of the experiment. Values for IVDMD decreased at each successive harvest date for both experiments. Percent ADF was lowest for E1 at the first harvest and increased as the season progressed. In E2, the lowest ADF value was at the second harvest, with the maximum occurring at the third harvest date. Percent NDF for both experiments was lowest at the second harvest and highest at the third harvest. Dry matter yield was highest at first harvest and lowest at second harvest for both E1 and E2.

Table 1. Mean IVDMD, ADF, NDF, and herbage dry matter yield of E1 and E2 orchardgrass.

		Year 1		Year 2	
	Harvest	E1	E2	E1	E2
IVDMD (%)	Spring	63.5	59.8	63.5	60.6
	Summer	51.1	51.4	57.8	59.7
	Fall	62.2	62.4	48.6	48.8
L.S.D. (0.05)		0.7	0.7	0.7	0.6
ADF (%)	Spring	32.1	34.7	33.4	35.7
	Summer	38.8	39.1	35.2	34.5
	Fall	26.2	26.1	37.7	38.0
L.S.D. (0.05)		0.4	0.4	0.3	0.4
NDF (%)	Spring	55.9	60.2	59.3	62.5
	Summer	62.2	62.6	57.9	57.6
	Fall	49.1	49.2	63.1	63.8
L.S.D. (0.05)		0.5	0.4	0.5	0.4
Yield (Kg/plot)	Spring	1.2	1.5	1.0	1.2
	Summer	0.6	0.7	0.1	0.2
	Fall	0.3	0.2	0.7	0.6
L.S.D. (0.05)		0.1	0.1	0.1	0.1

The orchardgrass quality data demonstrated to us that adequate genetic variation is available to modify these quality parameters through plant breeding. We have developed two synthetics from these materials and are presently increasing seed supplies to evaluate them in replicated grazing trials.

Many tall fescue lines and their progenies have been examined for their photosynthetic efficiency and desirable leaf growth characteristics. This work is being done in cooperation with C. J. Nelson (Agronomy). It has been demonstrated that the rate of leaf area expansion was positively associated with yield of forage regrowth in the field. Leaf area was determined by multiplying leaf width by rate of leaf elongation. A selection experiment has been initiated whereby we have been selecting for leaf area expansion with the ultimate objective of improving vegetative forage yields. The original source population (C_0) included a broadbased population of 1,000 plants selected for early maturity. We are now in our fifth cycle of selection. We have been selecting the upper and lower 5% to perpetuate the next cycle. Plants expressing a low leaf area expansion rate have high tillering rates and we anticipate that these could be used for turf. It is hoped that the selections for rapid leaf area expansion could be used to improve vegetative forage yields.

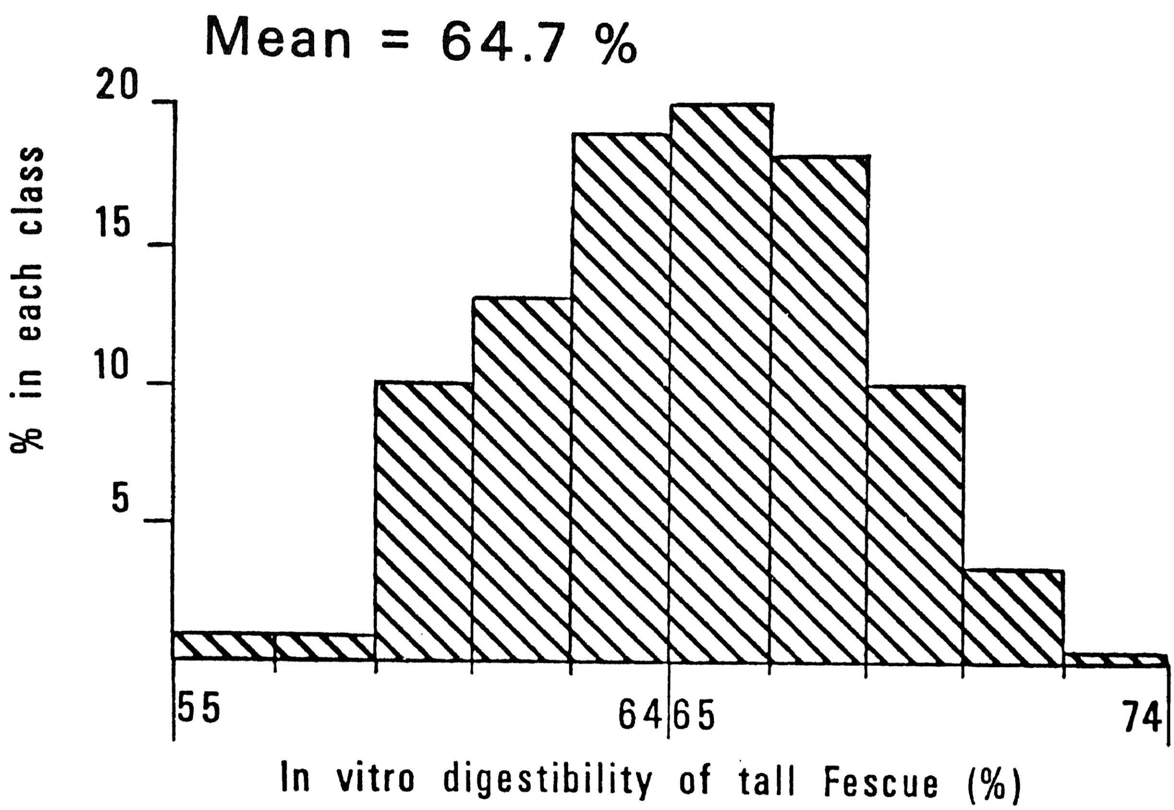
During the past several years, we have put considerable effort into the breeding program to study the genetic variation and heritability of minerals in tall fescue. Improper levels of minerals in forages can cause diseases such as grass tetany in grazing cattle. Grass tetany seems to be a complex problem as it is related to both a low level of magnesium in the ingested forage and poor absorption of magnesium in the intestinal tract. Several researchers have also demonstrated the importance of the K/(Ca+Mg) ratio and its relationship to grass tetany. When the ratio is less than 2.2, the incidence of grass tetany is reduced. Table 2 contains heritability estimates for Mg and K/(Ca+Mg) (Meq/100g dry matter). These values indicate that it should be possible to manipulate these minerals through plant breeding. First, second, and third harvest values were obtained in early May, mid-July, and early November of each year, respectively.

Table 2. Heritability estimate calculated by the progeny-parent regression method for Mg and K/(Ca+Mg) in tall fescue.

Mineral	Year	Heritability (%) First Harvest	Second Harvest	Third Harvest
Mg	1	57	74	69
	2	52	57	65
K/(Ca+Mg)	1	97	84	65
	2	69	31	45

Research for developing a tall fescue variety for fall and winter grazing is in progress using introductions from Tunisia, North Africa. These introductions that have proven only slightly winterhardy have been crossed to native winterhardy clones. The resulting hybrids are vigorous with growth continuing farther into the winter than existing native varieties. Unfortunately, the hybrids have very low seed set. A backcross program has been undertaken, which entails crossing the low seed set but vigorous hybrids back to native winterhardy tall fescue clones, allowing the chance for an increase in seed set.

Improving the digestibility of tall fescue is an important consideration in breeding for improved quality. Data in the figure below were collected from several hundred genotypes grown at Mount Vernon and Columbia, Missouri, in the fall. The range for all genotypes was from 55 to 74%. This indicates that there is variation for digestibility in tall fescue. We are utilizing this in the breeding program by developing lines that are higher in digestibility.



Research on using tall fescue for turf is continuing with the cooperation of J. H. Dunn (Horticulture). Much of Missouri is located in the "transition" zone of the United States. This area is south of the optimum range of bluegrass and too far north for the warm season turf species. Varieties such as 'Kentucky 31' and 'Alta' have been used for lawn and turf, but have been criticized for excessive coarseness. Tall fescue is well adapted to this region and selection is being placed on fine leaves, short growth habit, dense sod, drought tolerance, and resistance to disease. A variety trial which includes several of the University of Missouri's turf selections has been planted and will be evaluated for several years at both the Southwest Center and at Columbia, Mo.

BIRDSFOOT TREFOIL IN SOUTH MISSOURI

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Department of Agronomy

Abstract: Trefoil produced more forage and was more persistent at pHs of 5.3 and above than at pHs 4.7. Raising pHs with lime did not improve establishment, however, and also did not affect the amount of phosphorus available for plant growth. Trefoil reached 95% of maximum yield at soil phosphorus levels of about 60 lbs/A. Increasing phosphorus level above 100 lbs/A tended to decrease trefoil persistence due to increased competition from invading weeds.

Trefoil has persisted satisfactorily in mixtures with orchardgrass, but cutting frequency affects productivity of the mixture and the amount of trefoil present. Cutting trefoil during the critical fall period appears to decrease the following spring yield.

An experiment was established in the spring of 1972 to determine levels of lime and phosphorus that are necessary for successful establishment and growth of trefoil. Other research has shown that trefoil does not require as much lime (to raise pHs) as alfalfa for optimum growth. Upland soils in Southwest Missouri naturally have a low pHs and often are very low in phosphorus. While many grasses may grow fairly well with low levels of phosphorus, legumes usually have higher requirements. We were hopeful that our data would give insight into the necessary soil treatments for interseeding or renovation of grass pastures with trefoil. The first data was taken in 1973 and the experiment is still in progress.

Different pHs levels (Table 1) were achieved by adding 0, 2, or 4 tons/A of dolomitic limestone. Within each pHs level eight phosphorus (P) levels (Table 2) were established. Phosphorus was plowed down in spring, 1972, and starter treatments were banded at seeding on April 12. Phosphorus topdressing treatments began in late summer, 1972, and were repeated annually through 1976 after which no further phosphorus has been added. All plots have been topdressed annually with 100 pounds of potash (K) in late summer, beginning in 1972. Plots were harvested four times in 1974.

Lime applications significantly affected the K test level in all 5 years (Table 1). Original K level in the soil was 195 lbs/A and pHs was 4.6.

Table 1. Effect of soil acidity (pHs) on soil test levels (lb/A) of K and yield (T/A) of birdsfoot trefoil. P_2 was not affected by pHs and averaged 178, 165, and 139 lbs/A for 1973, 1974, and 1975 respectively.

	1973		1974		1975		1976		1977		1978	1979	
phs	K	T/A	K	T/A	K	T/A	K	T/A	K	T/A	T/A	K	T/A
4.7	187	2.45	211	2.48	250	1.39	310	1.36	252	1.39	1.23	273	1.27
5.3	181	2.58	189	2.62	225	1.47	272	1.55	227	1.64	1.30	249	1.36
5.7	167	2.61	183	2.66	220	1.46	259	1.59	225	1.57	1.19	260	1.19
LSD* 0.1	14	0.10	17	0.11	20	ns	28	.13	23	.12	.06	18	.09

*For statistical purposes values exceeding this level are considered to be significantly different. ns means not significant.

K level is tending to increase with time at all pHs levels indicating that the 100 lb/A topdressing is greater than the amount removed by the crop. Trefoil yields were probably not limited by K level as Dr. T. R. Fisher (Mo. Agr. Exp. Sta. Bull. 1007) reported that an alfalfa-grass mixture reached 100% of yield potential at K levels of about 160 lbs/A.

Table 2. Soil test values following phosphorus treatments. Plowdown and starter were begun in spring, 1972, and annual topdressing treatments continued from fall, 1972, through fall, 1976.

Treatments, Lbs P/Acre			P_2 Soil Test Level, Lbs/Acre					
Plowdown	Starter	Topdress	1973	1974	1975	1976	1977	1979
0	0	0	37	33	33	22	19	26
0	0	50	46	70	77	83	96	79
0	50	0	51	42	33	26	23	30
0	50	50	76	110	112	96	103	92
150	50	0	151	143	92	59	54	56
150	50	50	200	249	233	213	216	197
300	50	0	270	316	170	154	110	109
300	50	50	289	361	364	319	317	197

Excellent stands of Dawn birdsfoot trefoil were obtained under all fertility and lime treatments. Apparently birdsfoot trefoil may be established under considerably lower soil pHs and phosphorus levels than those required for alfalfa.

There was no pHs by phosphorus interaction on total yield per season or on Bray's P_2 test, so data were averaged over pHs levels. Lime applications significantly raised pHs, but did not significantly change the P_2 test. Even so, yield at pHs 4.7 was significantly lower in 4 of 5 years than at the higher pHs levels. These data suggest that trefoil responds to lime applications up to pHs levels of 5.3 to 5.4.

Phosphorus soil test levels were greatly affected by P applications (Table 2). Even those plots receiving no P treatment are testing higher now than the 13 lbs/A before the native vegetation was plowed. Except where high rates of plowdown P were used, soil test value for Bray's P_2 test are decreasing when no annual topdressing is added. Topdressing annually with P has caused an increased soil test level in all cases, which suggests that annual removal was less than 50 lbs/A. This is now being evaluated more critically as phosphorus is no longer being topdressed onto the plots.

Forage yield was related to Bray's P_2 soil test level and is shown in Figure 1. For more accurate interpretation all data within each year were transferred to a percentage basis. Using combined data, 95% of maximum yield level occurred at a P_2 level of about 60 lbs/A. Yield levels of 95% of maximum are more economic than 100%, as it would take almost 50 lbs/A more on the P_2 test to produce the last 265 lbs/A of forage to achieve the 100% yield. The data for 1977 shows the same trend as that of the earlier 4 years.

First harvests for 1975, 1976, and 1977 were taken about May 15. We were particularly interested in weed invasion into the plots, and so separated harvested samples into trefoil and weed components. Interactions between soil pHs and P_2 level were not significant for yield or botanical composition so data for each factor were averaged over the other variable. However, P_2 levels up to about 100 lbs/A increased the trefoil component (Figure 2). Data for 1977 was similar.

Weed invasion was significantly higher at pHs 4.7 as 51% of the yield consisted of winter annual weeds and cool-season grasses while both of the other lime levels had only about 41% of invading species. Evidently lime treatment increased vigor of trefoil enough to offer more competition to invading weeds and grasses. This was apparently also reflected in higher seasonal yields (Table 1) when lime was added to raise pHs.

Another experiment was designed to measure the ability of Dawn birdsfoot trefoil to yield and persist under different cutting managements. It is recognized that trefoil is much better adapted to frequent defoliation (similar to continuous grazing) than is alfalfa or other upright legumes, providing some green leaf area remains to provide photosynthate to support the plant during regrowth. This characteristic, coupled with a natural reseeding habit, makes trefoil one of the best adapted legumes available for grass mixtures in pastures.

Stands of trefoil and trefoil-orchardgrass were established in April 1972, and treatments were imposed beginning in spring 1973. Plots are topdressed annually with 0-75-240 to insure that adequate P and K are available. Orchardgrass was seeded in half the plots as grasses may actually aid persistence of legumes by

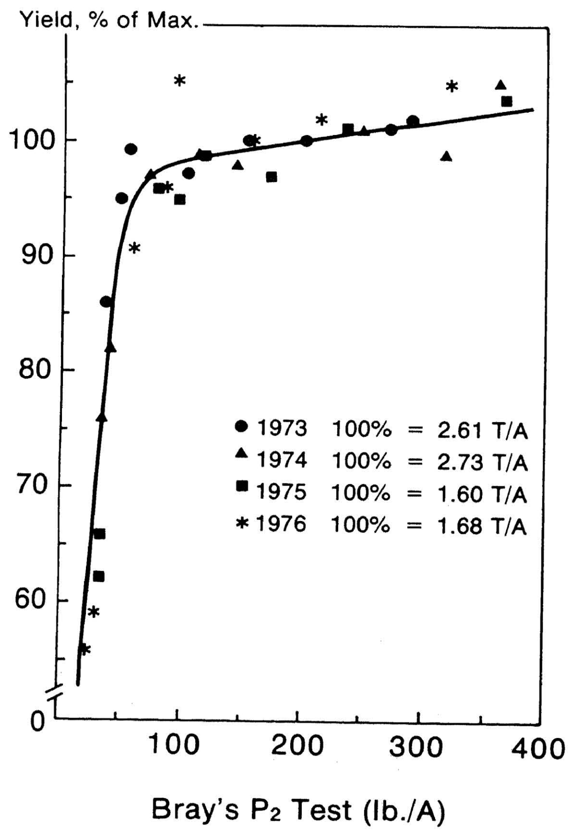


Figure 1. Forage yield of birdsfoot trefoil as affected by soil level of P.

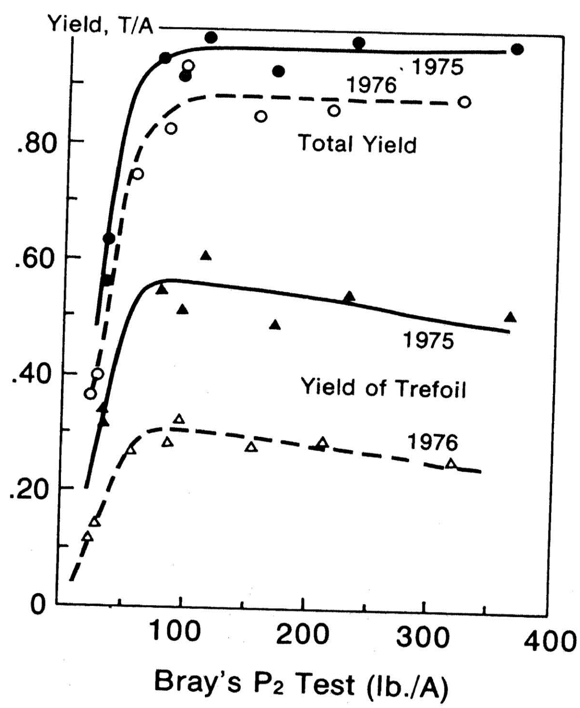


Figure 2. Yield of total forage and trefoil only in first cutting as affected by soil level of P.

providing a mulch-like canopy in winter and also by preventing weed invasion.

Cutting treatments and forage yields of trefoil grown alone are shown in Table 3. A wide range in yield occurred in 1973 which often happens during the first treatment season. Weed invasion was minimal, the trefoil plants were young and vigorous, and the treatments had not begun to have a great effect.

Table 3. Cutting frequencies and yield response of birdsfoot trefoil seeded in Spring 1972.

		Forage yield T/A				
Cutting Treatment	Code	1973	1974	1975	1976	1977
May 1, then every 15 days to Sept. 1	15 - FC	1.98	2.18	1.30	1.24	1.44
May 1, then every 15 days to Oct. 15	15 + FC	2.32	2.22	1.22	1.17	1.56
May 15, then every 30 days to Sept. 1	30 - FC	2.08	2.58	1.70	2.31	2.25
May 15, then every 30 days to Oct. 15	30 + FC	2.70	2.67	1.67	2.11	2.51
May 30, then every 45 days to Sept. 1	45 - FC	2.64	2.45	1.88	2.17	2.50
May 30, then every 45 days to Oct. 15	45 + FC	3.68	3.13	2.36	2.34	2.78
least significant difference (0.05)		0.17	0.15	0.13	0.31	.24

In general, plants cut less frequently had the highest yield as less time was spent in the slower growth rate periods following cutting. Fall cutting in 1973 during the normal critical period of September 1 to October 15 increased yield in all three basic cutting managements. During 1974, treatment effects began to show up as the range in yield was decreased and particularly at frequent cutting. During 1975 and 1976 yield was lower where cutting occurred during the critical fall period. Previous research by Dr. A. G. Matches, ARS, USDA, and the University of Missouri has shown that vigor and persistence of trefoil cut infrequently is often reduced. In our experiments, treatments cut every 15 days or 30 days retained their productivity indicating that birdsfoot trefoil is adapted to more frequent defoliation. During 1975, we noticed a great deal of weed invasion into plots cut infrequently where trefoil was seeded alone. Weeds continued to invade in 1976, and in 1977 these plots were discontinued. This shows the value of having a grass in the mixture with birdsfoot trefoil.

Table 4 shows the effects of the same treatments as in Table 3 on a birdsfoot trefoil mixture with orchardgrass. Orchardgrass has many desirable features for growing in mixtures with trefoil, especially its upright growth habit and lessened sod-forming characters. Yields of the mixture were slightly lower than for trefoil grown alone (weeds are included in yield, Table 3) but showed a similar relationship between 1973 and 1974. During 1975, 1976, and 1977, the mixture yielded more than did trefoil alone in most treatments.

Of greater interest though is the persistence of trefoil in the mixture. Herein both the natural ability of trefoil plants to avoid stress and their ability to reseed are of concern. During 1973, those plots cut every 15 days retained a high level of trefoil in the mixture (near 60%) while under the 30-day management the percentage was reduced. Trefoil percentage was highest in the 45-day treatment. During 1974, the trefoil component was reduced to about 35% of the mixture under the 15-day treatment, but remained higher (40-45%) in other treatments. Even though trefoil is more tolerant of frequent cutting than many other legumes the 15-day frequency was apparently affecting productivity. However, by 1975 when persistence was more dependent on reseeding, the trefoil percentage actually increased again with little difference between cutting treatments. That percentage remained through 1976 and 1977.

Table 4. Response of birdsfoot trefoil-orchardgrass mixture to cutting treatments. Percentage trefoil in mixture was calculated from botanical separations for each cutting throughout the growing season.

	Yield (T/A)						
Treatment	1973	1974	1975	1976	1977	1978	1979
15 - FC	1.56	1.89	1.37	1.49	1.69	1.09	1.49
15 + FC	1.92	2.10	1.25	1.38	1.78	1.14	1.40
30 - FC	2.04	2.03	2.21	2.60	2.70	1.56	1.82
30 + FC	2.50	2.40	1.82	2.50	2.86	1.42	2.01
45 - FC	2.76	2.38	2.61	3.38	2.82	1.67	2.38
45 + FC	3.51	2.57	2.80	2.74	2.84	1.65	2.48
LSD .05	0.17	0.15	.32	.60	0.49	.20	.43
$\bar{x}$	2.38	2.23	2.01	2.35	2.45	1.42	1.93

	% Trefoil						
Treatment	1973	1974	1975	1976	1977	1978	1979
15 - FC	60.3	35.4	46.6	45.4	45.4	20.0	37.9
15 + FC	60.5	34.8	43.5	44.5	43.9	18.6	34.4
30 - FC	53.8	40.9	44.9	49.9	41.3	18.5	36.7
30 + FC	51.4	40.4	47.2	45.7	43.4	19.0	33.9
45 - FC	67.5	45.8	41.0	53.6	37.8	31.9	26.7
45 + FC	65.3	45.1	49.0	51.3	42.6	31.5	34.3

The natural reseeding habit of trefoil will have to be evaluated over several years. In order to get new seedlings established it is generally recognized that competition will need to be kept to a minimum. In that case once the original plants die, which may be sooner in the frequent cuttings, persistence will be totally dependent on getting some seed produced and having competition decreased enough to make natural re-establishment possible. In the latter case the more frequent cutting may compensate by allowing easier establishment to perpetuate the stand, even though seed yield may be lower than for other treatments.

The influence of fall management on ability to overwinter and on subsequent spring production is of major concern in legume persistence. Table 5 shows the yield of the trefoil-orchardgrass mixtures in fall and the following spring.

Comparisons should be made only for the influence of fall cutting within each cutting frequency. No management differences occurred during 1972, so spring yields as affected by fall cutting were not significantly different (ns). Even though half the plots were cut during fall, 1973, they still performed at the same level in spring, 1974, as their uncut counterparts. Treatments of cutting every 15 days gave three extra cuts during the critical fall growth period adding 0.29 T/A to the 1973 yield. The 30 day treatment was cut twice and added 0.31 T/A, and the 45 day treatment was cut only on October 16 and gave 0.72 T/A additional yield.

Cutting during fall, 1974, also increased yield for the 1974 growing season with only a moderate effect on spring, 1975, growth. No significant difference occurred in the least or most frequent cutting, but spring yield was reduced by fall cutting in the 30-day treatment. Contribution of fall growth to yield in 1976 was very small due to the dry weather. Even so, cutting had a detrimental effect on productivity in spring, 1977. Cutting during fall, 1977, had a similar effect on yield in spring, 1978.

Table 5. Response of birdsfoot trefoil-orchardgrass mixture to fall cutting and subsequent spring cutting. Spring cuttings were on May 1-8, May 15, and June 1-3 of 15, 30, and 45 day treatments respectively. Yields are given in tons per acre.

Treatment	Fall 1973	Spr. 1974	Fall 1974	Spr. 1975	Fall 1975	Spr. 1976	Fall 1976
15 - FC	0	0.68	0	0.47	0	0.47	0
15 + FC (3)	0.29	0.66	0.18	0.35	.18	0.26	0.02
30 - FC	0	1.11	0	1.59	0	1.03	0
30 + FC (2)	0.31	1.04	0.24	1.02	.12	0.82	0.03
45 - FC	0	1.59	0	1.89	0	2.11	0
45 + FC (1)	0.72	1.54	0.16	1.86	.25	1.38	0.04
LSD (0.05)	0.12	ns	0.06	0.20	.02	0.48	0.01

Repeat Treatments	Spr. 1977	Fall 1977	Spr. 1978	Fall 1978	Spr. 1979	Fall 1979	Spr. 1980
15 - FC	.53	0	.33	0	.61	0	0.65
15 + FC (3)	.39	0.21	.16	.02	.48	.11	0.45
30 - FC	1.25	0	.66	0	.74	0	1.00
30 + FC (2)	1.12	0.16	.41	.02	.56	.26	0.84
45 - FC	1.66	0	1.05	0	1.34	0	1.43
45 + FC (1)	1.47	0.23	0.86	.04	1.17	.10	1.40
LSD (0.05)	.31	0.02	.17	.01	.30	.03	.22

At each cutting the plants are not completely defoliated and leaf area was left to carry on photosynthesis to give the plant energy for regrowth. Again, the long range response of repeated cutting during the fall hardening period is not yet established. The influence of cutting on seedling development as the stands become more dependent on new seedlings will be critical. Therefore, these studies will become more valuable as dependence on reseeding for plant perpetuation becomes greater.

These data suggest that trefoil is adapted to more marginal soils in terms of pHs and phosphorus levels than we had anticipated and that both minimum and maximum phosphorus levels are experienced. If management systems for establishment and maintenance of trefoil in the stand are accepted, this legume could make an important contribution to the forage supply of South Missouri.

Soil Fertility Research With Forage Crops

Earl M. Kroth and Richard Mattas

Abstract: Results of soil fertility studies with cool and warm season grasses give guidance for the efficient fertilization of pastures. Phosphate and exchangeable K soil test values for the 0-3 inch depth are given, these levels to be maintained by judicious topdressings of P_2O_5 and K_2O. Preliminary results of P_2O_5 topdressings on red clover and red clover fescue stands are given.

SAVE ENERGY WITH EFFICIENT PASTURE FERTILIZATION: COW-CALF HERDS

I. Considerations
   1. Do not waste forage - produce only what cattle can use, this means:
      a. An optimum yield which can be utilized without an elaborate rotation system.
      b. An estimated optimum yield of 3 T/A hay equivalent. This equals:
         1) 6 Animal unit months
         2) 200 cow days
   2. Soils and Land Topography - County soil testing laboratories were established in the 1940's. Fertilizer recommendations were made from tests on soil samples taken from the 0-7 inch "plow layer 2,000,000 lbs." Pasture research in 1950's tested the production of different grasses and legumes on plowable "rotation" land fertilized to "soil test". In 1945 tall fescue was introduced into South Missouri and rapidly spread to the hilly, stony, nonrotation soils of the state as the demand for pasture grew with the increasing numbers of beef cattle, Figure 1. The economical fertilization of these soils is different from that of rotation land also used for row crops in addition to occasional hay and pasture.
   3. Luxury Consumption- When plants grow slowly due to lack of a nutrient, the nutrient will be present in the plant tissue in a small amount. At this condition the nutrient is said to be at the "critical concentration". When plants are growing at a normal rate the nutrient will be present at an "adequate level".

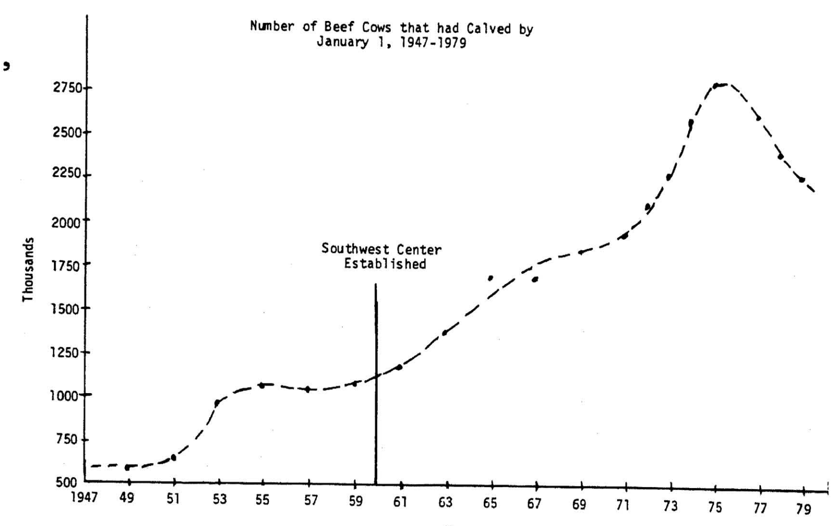


Figure 1. Increase in Beef Cow Numbers 1947-1979.

This "adequate level" is actually a range of concentrations, the higher amount could be considered a "reserve" which will be reduced when conditions slow the rate of absorption by the roots but the plant continues to grow at the normal rate. When high levels of N, P, K are present in the soil, nutrients will be absorbed above the "reserve" level. This phenomenon is called "luxury consumption". The quantity of nutrients absorbed to this level are not used by the plant but are consumed by grazing animals and recycled to the soil or removed as hay, and if sold, the excess nutrients are removed from the farm. Efficient fertilizer management would avoid "luxury consumption" as well as the "critical concentration" and would maintain the "adequate level" as much as possible, Tables 1 and 2, Figure 8.

4. Forage production varies - Rainfall amounts and distribution will make annual yields vary around the optimum average.
   a. Dry seasons - will need extra forage from some source.
   b. Wet seasons - plan to make hay of excess production.
5. Topdressing P and K fertilizers "feed the plant" -
   a. Topdressed P and K are rapidly absorbed by the plant when the soil is moist, especially in the spring when the soil surface becomes warm.
   b. Optimum amounts of topdressed P and K will not cause excessive luxury consumption but enough P and K will be absorbed so growth will continue as the surface soil drys out. Water for growth will be obtained by roots in the moist soil below. When the surface soil is rewet by rain, additional nutrients will be rapidly absorbed to continue plant growth and replenish the "reserve" supply in the plant tissue.
   c. P and K will not move below the top three inches of soil unless applied in excessive amounts. The greater portions will stay in the upper inch where they will be readily absorbed by roots near the soil surface.
   d. Excessive P and K topdressings will unnecessarily increase soil test values, Tables 1 and 2.

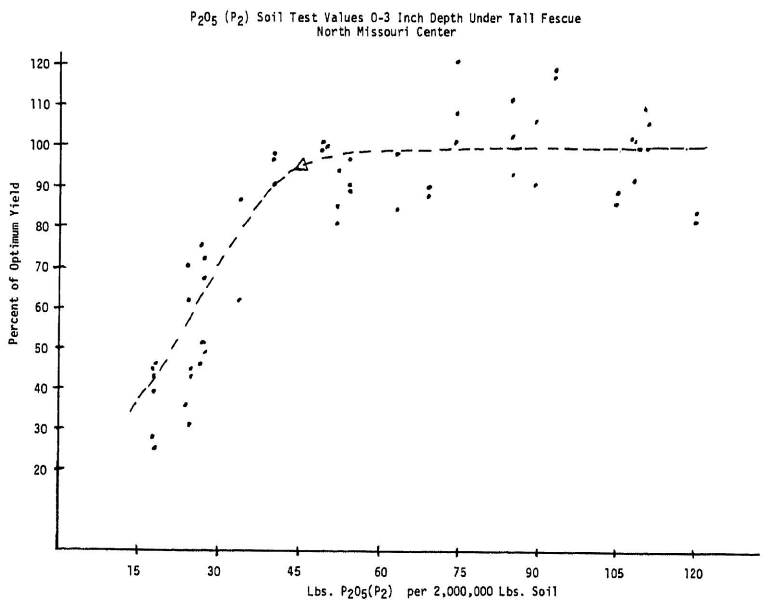


Figure 2. Relationship of soil test P_2O_5 (P_2) to yield of tall fescue.

II. Research Results: Cool Season Grasses

1. Seven years data with N P K topdressing studies on tall fescue and reed canarygrass at North Missouri Center have shown that 45 lbs P_2O_5 (P_2) and 85 lbs of exchangeable K/2,000,000 lbs of soil for the 0-3 inch layer are the soil test values, which when maintained by topdressings, will produce the average annual optimum yield of 3 T/A, Figures 2 and 3.
2. Where the forage is removed as hay, 30 lbs P_2O_5 and 50 lbs K_2O/A per year would maintain the above soil test values and produce the optimum 3 T/A year.
3. When forage is grazed and nutrients are recycled through animals, smaller amounts of P_2O_5 and K_2O will be needed to maintain these soil test values.
4. Where legumes (red clover) are in the pasture mixture, the same soil test values should be maintained. Topdressing studies with red clover-fescue and legume-reed canarygrass mixtures are near completion. Preliminary results from these studies show that these soil test values can be used as guides in topdressing P and K to cool season grass-legume pasture mixtures. Higher rates of P_2O_5 and K_2O may need to be applied when the mixture is removed as hay.
5. The studies mentioned in No. 1 above also showed 200 lbs N to be excessive. Comparison with yields produced by 100 lbs N indicated that 160 lbs N split into 80 lb applications, March and August, would be the most economical nitrogen management in the absence of legumes, (red clover, birdsfoot trefoil). These results are also applicable to south Missouri.

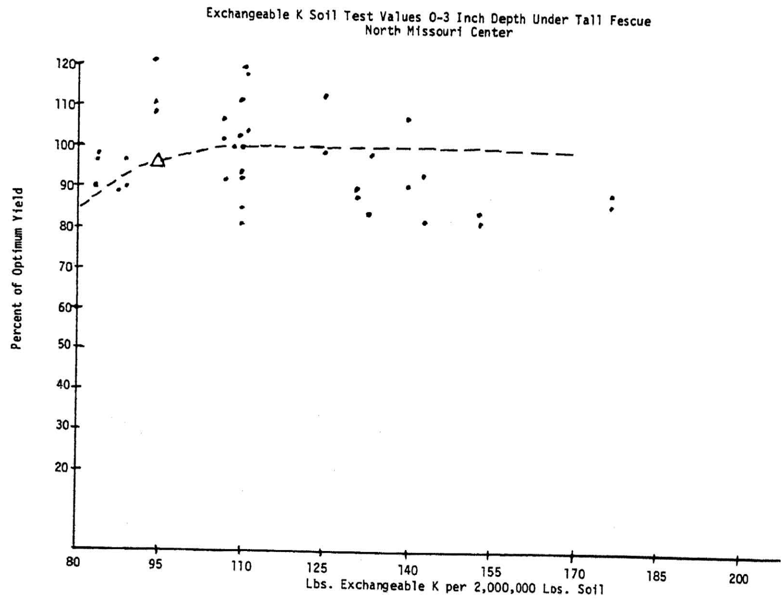


Figure 3. Relationship of soil test exchangeable K to yield of tall fescue.

III. Research Results with Warm Season Grasses - Results of topdressing studies with Caucasian bluestem and Blackwell switchgrass at the Southwest Center are given in Table 2. 60 + 30 + 50 topdressed annually gave the optimum average yield of 3 T/A for both grasses. The forage of these warm season grasses had a lower P and K content and removed less of the fertilizer P and K applied than did tall fescue resulting in higher P_2O_5 and exchangeable K 0-3" soil test values where 30 and 50 lbs P_2O_5 and K_2O respectively were applied. The relationship between yields of treatments getting 60 lbs N and final soil test values in lbs/2,000,000 lbs of soil are given in Figures 4, 5, 6, 7. Yields for 1965, 66, 67 were plotted against P_2O_5 (P_2) soil test values for 0, 30, 60 lbs P_2O_5 topdressed when K was adequate (50 lbs K_2O) and against exchangeable K soil test values for 0, 50, 100, 150 lbs K_2O when P was adequate (30 lbs P_2O_5). The final soil samples were taken in March 1978. The soil of the plots was too dry for sampling in the fall of 1977.

1. The data in Table 2 indicate that the warm season grasses do not require as much K for growth as tall fescue; their "critical" K concentration apparently is not as high as tall fescue nor is their tendency toward luxury consumption of K as great. Consequently 60 + 0 + 0 nearly produced the optimum yield of both grasses (The initial soil tests were 31 and 181 lbs/2,000,000 lbs of soil 0-7" of P_2O_5 (P_2) and exchangeable K, respectively).
2. Phosphorus limited yields more than K but Figures 4, 6, indicate a soil test value of 30 lbs P_2O_5 (P_2)/2,000,000 lbs of soil for the 0-3" depth would guarantee an average yield of 3 T/A/Yr of both grasses.
3. Figures 5, 7, indicate an exchangeable K soil test value of 135 lbs/ 2,000,000 lbs soil would produce the optimum yield of both grasses. In fact, if the forage of these studies had been grazed and the nutrients recycled through the animals, K probably would not have been needed. The 1977 growing season was exceptionally favorable for forage growth and the yield that year for the 60 + 0 + 0 treatment was 3.7 T/A; the yield for the 120 + 0 + 0 treatment was 4.8 T/A. The soil test exchangeable K, 0-3" was 127 and 108 lbs/2,000,000 lbs for the 60 + 0 + 0 and 120 + 0 + 0 treatments respectively.
4. These studies show that soil test values for the 0-3" depth of bluestem and switchgrass pastures of 30 lbs P_2O_5 (P_2) and 135 lbs exchangeable K/2,000,000 lbs of soil respectively would produce an average yield of 3 T/A of forage when removed as hay. These values would be maintained with an annual application of 60 + 30 + 50 in March. (Monitoring the soil test values for the 0-3" depth to maintain the 30 lbs P_2O_5 and 135 lbs ex K might show that an occasional topdressing could be eliminated.)
5. Data from Table 2 for the 120 + 30 + 50 annual topdressing show that these soil test values (30 lbs P_2O_5 and 135 lbs exchangeable K) would result, a higher yield being produced and more P and K removed by forage but requiring the 30 lbs P_2O_5 and 50 lbs K_2O be topdressed annually.
6. When these forages are adequately utilized by grazing beef cows and the N, P and K in the forage recycled to the soil, smaller rates of N P K fertilizer would be needed annually to produce the optimum grazeable forage. Judicious testing of the 0-3" depth of the pasture soils would monitor the nutrient levels of the pastures and guide the efficient use of expensive fertilizers to maintain an "adequate level" of P and K in the growing plants.

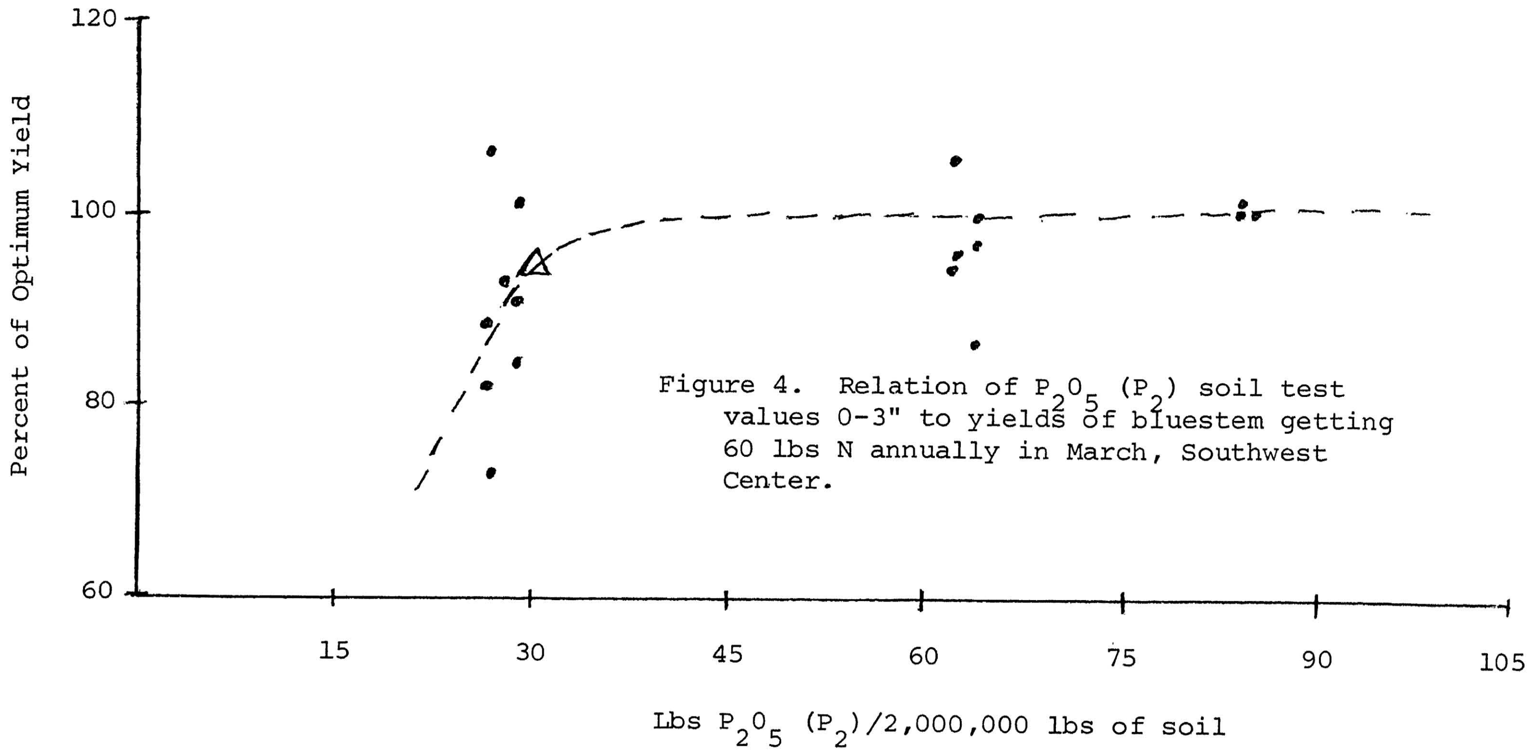


Figure 4. Relation of P_2O_5 (P_2) soil test values 0-3" to yields of bluestem getting 60 lbs N annually in March, Southwest Center.

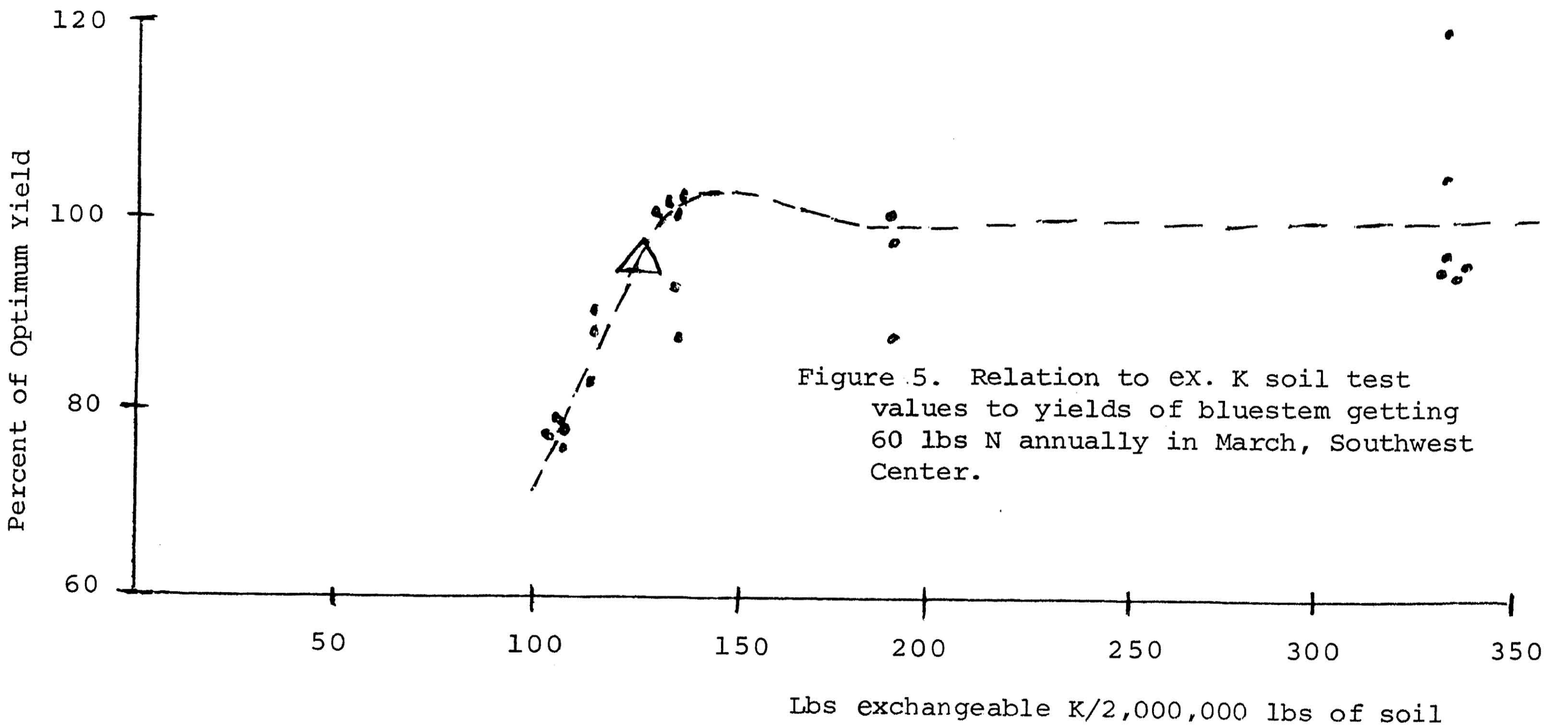


Figure 5. Relation to ex. K soil test values to yields of bluestem getting 60 lbs N annually in March, Southwest Center.

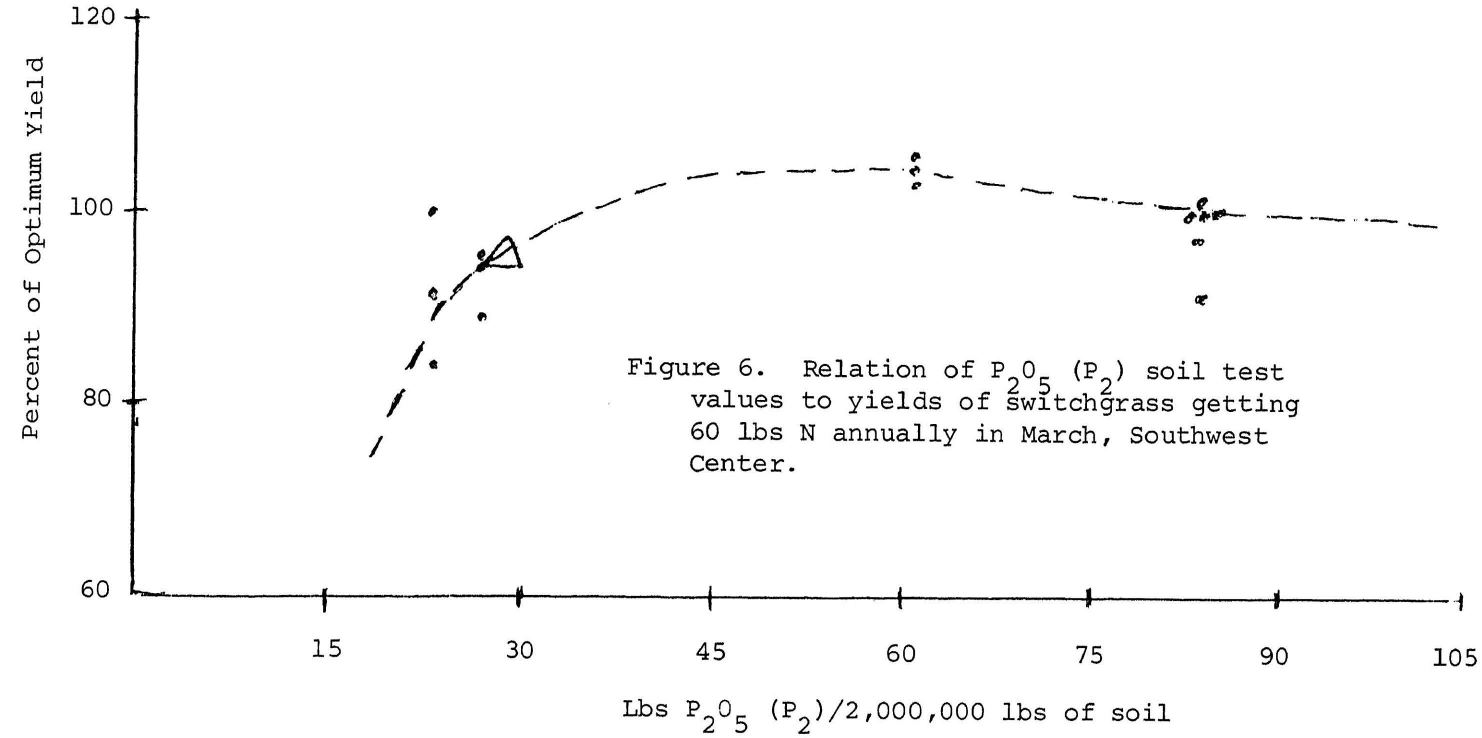


Figure 6. Relation of P_2O_5 (P_2) soil test values to yields of switchgrass getting 60 lbs N annually in March, Southwest Center.

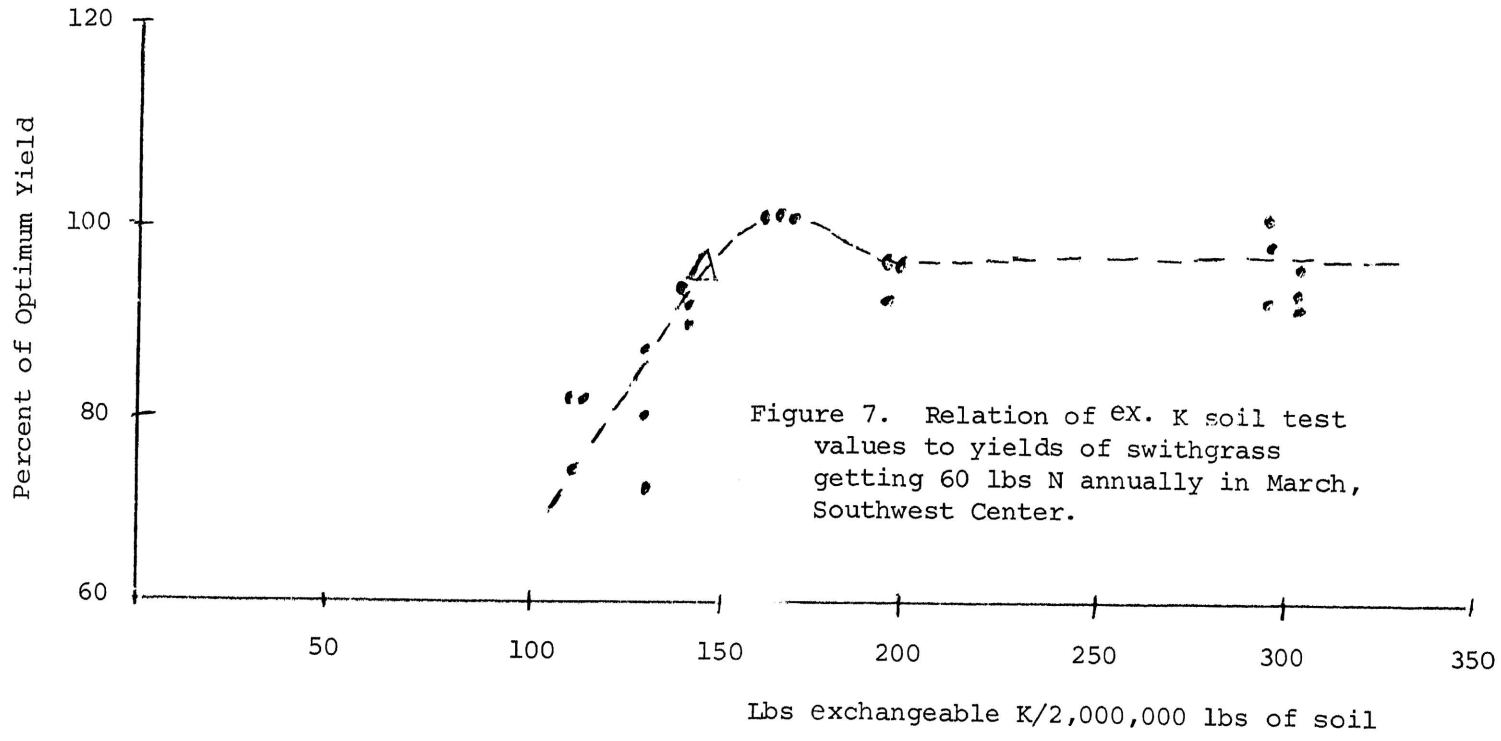
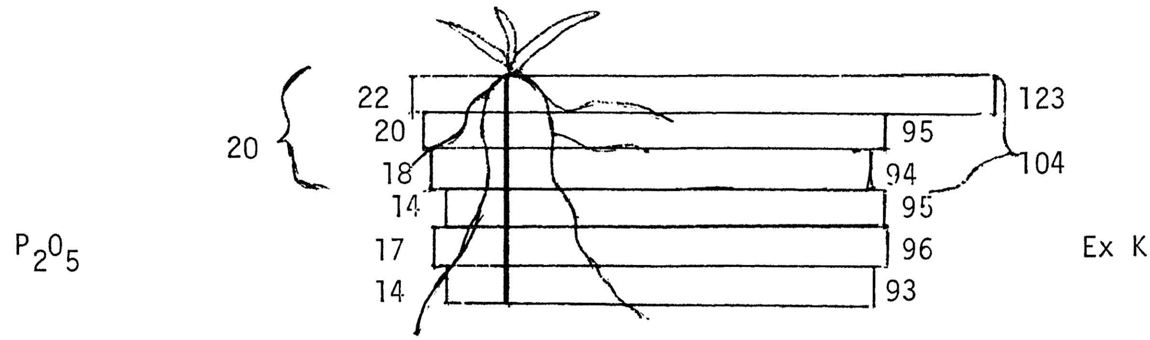


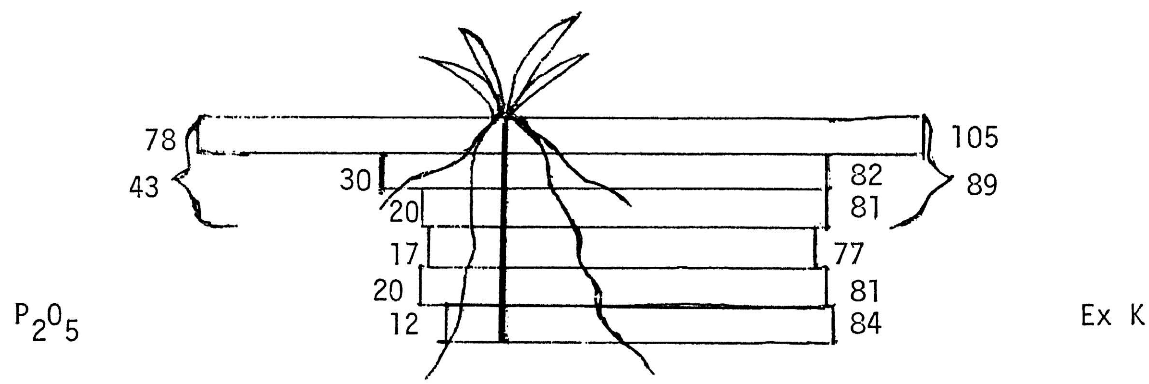
Figure 7. Relation of ex. K soil test values to yields of swithgrass getting 60 lbs N annually in March, Southwest Center.

Figure 8

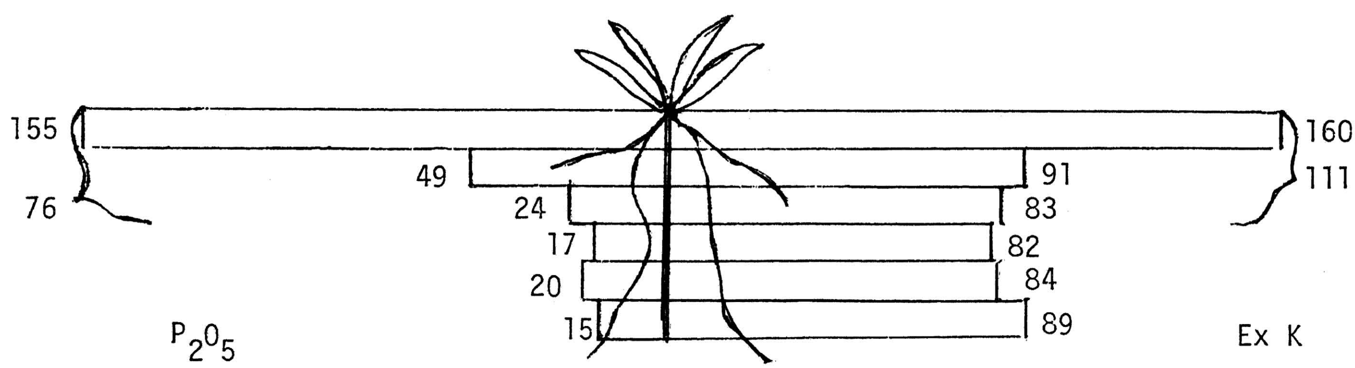
P_2O_5 (P_2) and exchangeable K, Lbs/2,000,000 lbs of Soil by Depths Under Tall Fescue Resulting from Different Topdressing
North Missouri Center
(See Table 1)



200 + 0 + 0
Yield = 1.7 T/A



200 + 30 + 50
Yield = 3.1 T/A



200 + 60 + 150
Yield = 3.5 T/A

Table 1. Yields, P and K concentration, total P and K removed by fescue forage and final soil test values, North Missouri Center.

Annual Topdressing	Yield 6 Yr. Ave.	P K Content Cut 1 P	Cut 1 K	Cut 2 P	Cut 2 K	Total P K Removed* P	Total P K Removed* K	Final Soil Test Values 0-3"** P_2O_5	Ex K
	T/A	%				lbs/A			
200 + 0 + 0	1.7	.11	1.26	.10	1.11	26	290	20	104
200 + 30 + 50	3.1	.19	1.40	.18	1.20	73	560	43	89
200 + 60 + 150	3.5	.23	1.90	.21	1.81	87	880	96	111

* Multiply lbs P by 2.29 to change to lbs P_2O_5 and lbs K by 1.20 to change to lbs of K_2O.
**lbs/2,000,000 lbs soil.

1. 200 + 0 + 0 produced a six year average yield of 1.7 T/A with the soil supplying the 26 lbs P (59 lbs P_2O_5) and 290 lbs K (348 lbs K_2O) needed to produce this yield.
2. 200 + 30 + 50 topdressed annually produced a six year optimum average yield of 3.1 T/A. A total of 180 lbs P_2O_5 and 300 lbs K_2O were applied by topdressings. The equivalent of 167 lbs P_2O_5 and 672 lbs of K_2O were removed in the forage. This treatment was a very efficient one making use of available K supplied by soil minerals and only 13 lbs of applied P_2O_5 were left in the soil. This quantity combined with that coming from soil minerals produced the 43 lbs P_2O_5/2,000,000 lbs soil test values.
3. 200 + 60 + 150 increased the six year average yield by only .4 T/A, caused excessive "luxury consumption" of P and K and unnecessarily increased the P_2O_5 and exchangeable soil test values.

Table 2. Yields, P and K concentration, total P and K removed by forage and final soil test values under warm season grasses, Southwest Center.

Annual Topdressing	Yield 6 Yr. Ave.	P K Content* Cut 1 P	Cut 1 K	Cut 2 P	Cut 2 K	Total P K Removed P	K	Final Soil Test Values 0-3"** P_2O_5	Ex K
	T/A	——— % ———				lbs/A			
Blue Stem									
60 + 0 + 0	3.1	.11	1.02	.09	.85	27	251	37	127
60 + 30 + 50	3.8	.18	1.38	.13	.95	51	384	84	135
60 + 60 + 150	4.0	.20	1.74	.14	1.03	59	491	186	427
120 + 0 + 0	3.8	.10	.96	.08	.76	28	271	31	108
120 + 30 + 50	4.8	.17	1.30	.13	.86	60	443	58	135
120 + 60 + 150	5.1	.19	1.84	.14	1.03	71	624	165	302
Switchgrass									
60 + 0 + 0	2.7	.09	.76	.10	.73	26	206	22	112
60 + 30 + 50	3.2	.19	1.16	.20	.97	63	358	84	167
60 + 60 + 150	3.1	.22	1.55	.19	1.19	66	481	156	473
120 + 0 + 0	3.2	.09	.84	.09	.75	29	262	20	118
120 + 30 + 50	4.4	.18	1.02	.16	.86	77	427	53	122
120 + 60 + 150	4.1	.21	1.65	.19	1.13	85	609	158	277

* P, K values for 1977 only. These values used to estimate total P and K removed by forage.

** Soil test values are lbs/2,000,000 lbs of soil

SUPPLYING P AND K TO RED CLOVER AND RED CLOVER - TALL FESCUE BY TOPDRESSINGS.

Excellent stands of pure Kenstar red clover and Kenstar red clover - tall fescue mixture were obtained by drilling 85 lbs 0-44-0 with the red clover and 85 lbs 18-46-0 with the fescue in August 1977. The initial soil test values for the 0-7" was 50 lbs P_2O_5 and 190 lbs exchangeable K/2,000,000 lbs of soil. Plots were set up on these stands to provide plots for 9 different combinations of P_2O_5 and K_2O topdressings. These topdressings were applied annually.

This study was intended to be a red clover seed production study testing the effect of honeybees as supplemental pollinators and the fertility needs in red clover seed production. Inability to thresh red clover seed plots effectively changed the study to a forage production study only. The effect of topdressing P_2O_5 and K_2O on forage yields are given in Table 3.

These preliminary data confirm the following:

1. Forage yields of about 3 T/A are average for the available soil moisture during the growing season in Southwest Missouri.
2. Some slight response to additional P_2O_5 and K_2O singly is indicated.
3. To date no effect of P_2O_5 and K_2O combinations are indicated.
4. The selected P_2O_5 and K_2O topdressing rates are too high to show effects on forage yields. Application rates will be reduced for the remainder of the study.

Table 3. Effect of Topdressing P_2O_5 and K_2O on Yields of Red Clover and Red Clover - Tall Fescue Mixture.

	Forage Yields					
	Red Clover			Red Clover-Tall Fescue		
Treatment	1978	1979	1980*	1978	1979	1980*
	Tons/A					
0 + 0 + 0	3.2	2.1	1.3	3.2	1.6	1.5
0 + 40 + 0	3.3	2.6	2.2	3.4	2.5	2.2
0 + 80 + 0	3.3	2.6	2.3	3.2	2.5	2.0
0 + 0 + 150	3.0	1.9	1.6	3.1	2.0	2.0
0 + 40 + 150	2.9	2.4	2.8	3.4	2.7	2.1
0 + 80 + 150	2.9	2.5	2.9	3.4	2.6	2.5
0 + 0 + 300	3.1	2.4	1.6	3.3	2.1	1.9
0 + 40 + 300	3.0	2.6	2.7	3.6	2.8	2.3
0 + 80 + 300	3.1	2.5	2.8	3.3	2.8	2.2

*Harvests 1980 to date were on 5/29 and 7/7. An additional harvest in September is expected.

ALTERING FORAGE MAGNESIUM WITH SOIL TREATMENTS
FINAL REPORT[1]

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Abstract: The delay of top dressing of N-P-K fertilizer from late winter to mid-May had two significant results. The dry matter production season of tall fescue was extended with no effect on total annual production. Second, the cation ratio of the forage grown on plots with the delayed fertilizer application was lower than in forage grown on late winter treated plots; thus, the tetany proneness of the forage would be reduced by delayed application of fertilizer.

One of the many factors which helps to trigger outbreaks of grass tetany in cattle is the content of magnesium in the forage the animals eat. Based upon information gleaned from work in other areas of the U.S. and world,a study was initiated in 1972 at the Southwest Center. The objective of the study was to determine the effect of lime sources and timing of top-dressed N, P, and K on the concentration of Mg in fescue tissue at several times during the year.

In this study there are four basic treatments as follows:

- Dolomitic limestone at one half the recommended rate
- Magnesium oxide to supply 240 lbs Mg per acre
- Dolomitic limestone as above plus 72 pounds of elemental sulfur
- Calcitic limestone at one half the recommended rate

These four basic treatments were worked into the plow layer of Gerald silt loam in 100' x 35' blocks prior to seeding Kentucky 31 fescue in the spring of 1972.

Plots were laid off in 10 35' x 10' plots per block. Half of the plots in each block received 240 lbs Mg/A as MgO worked into the surface soil. Five timing treatments of top dressed fertilizer based upon 1972 recommendations were selected as follows:

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[1]The enclosed is a summary. The complete study will be reported in a Missouri Agricultural Experiment Station Research Bulletin.

[2]The following persons also performed a large amount of work on this study: Robert Light, Richard Mattas, William Rice, Boyd Strong, Al Hoggard, M. Farley, John Kerr and Bruce Evers.

Number	Treatment Time January	after first harvest	August
	lbs/A*		
1	80 + 40 + 80	0	80 + 0 + 0
2	80 + 40 + 40	0	80 + 0 + 40
3	0	80 + 40 + 40	80 + 0 + 40
4	0	80 + 40 + 80	80 + 0 + 0
5	80 + 40 + 40	40 + 0 + 40	40 + 0 + 0

*N + P_2O_5 + K_2O

In 1976, 1977, and 1978 the K treatments were changed to 50 and 100 lbs K_2O/A instead of 40 and 80, respectively.

The sampling and harvest plan selected was a compromise to simulate grazing where grazing would be impractical due to plot numbers and size. The fall growth was allowed to accumulate and go dormant. In January or February after being leached by November and December precipitation, the fall growth was removed, dry matter yields were determined and the material analyzed for K, Ca, and Mg. The "January" treatment was applied after removal of the stock piled material. When the new spring growth reached a 5-inch leaf length, grab samples from each plot were taken periodically and analyzed for K, Ca, and Mg. The entire growth was harvested at initiation of seed head emergence for yield and analysis. Soil samples from each plot were taken and the appropriate top dress treatments were made after the first harvest. The late spring-summer growth was harvested for yield and analysis in early July, after which the August treatment was applied. After the first frost, periodic grab samples were taken until growth ceased. (The January or February harvests are considered as yield of the previous calendar year.)

The dry matter yields from the six years of this study illustrate two points (Table 1). First, there was little effect of the timing of top dressing upon total annual dry matter. Second, the delay of application from late winter (Treatments 1, 2, and 5) to mid-May (Treatments 3 and 4) significantly extended the dry matter production period.

It seems logical, therefore, that a delay in the spring top dressing to May would actually increase the effective amount of dry matter production. The late winter application in a grazing situation would stimulate growth that might be wasted due to trampling. The May application could effectively extend the grazing season.

Neither the lime treatments nor the supplemental Mg had any effect upon dry matter yields.

The delay in K application to the soil from late winter to mid-May decreased the K concentration in the forage. There was no great increase in Mg in the forage due to the delay in fertilizer treatment. The net effect of the treatments is best shown in the cation ratio data (Table 2).

The ratio is calculated by dividing the chemical equivalents of K in the forage by the sum of the equivalents of calcium and magnesium ie. K ÷ (Ca + Mg) or K/(Ca+Mg). This ratio when >2.2 is used to indicate forage that may cause grass tetany.

In this study no samples had a cation ratio >2.2. However, the delay in application of the topdressing from late winter to mid-May did significantly lower the ratio (Table 2). This effect was primarily due to the K availability.

Table 1. Effect of top dressing treatments on dry matter production of tall fescue by harvest and year.

Treatment	Year	Harvest 1	Harvest 2	Harvest 3	Total
		--------lbs/A--------			
1	1973	4030	2860	2040	8930
	1974	2880	800	2160	5840
	1975	2920	460	1400	4780
	1976	2930	1380	--	4310
	1977	3240	1270	2890	7400
	1978	3920	1320	780	6020
	Avg	3320	1350	1540	6210
2	1973	3920	2960	2180	9060
	1974	2820	880	2520	6220
	1975	2740	460	1560	4760
	1976	2720	1340	--	4060
	1977	3160	1240	3070	7470
	1978	3820	1360	750	5930
	Avg	3200	1370	1680	6260
3	1973	4080	2760	2100	8940
	1974	1280	2100	2600	5980
	1975	1440	1340	1720	4500
	1976	1440	2480	--	3880
	1977	2300	2260	3020	7580
	1978	2280	2300	900	5480
	Avg	2130	2210	1720	6060
4	1973	3890	2830	1940	8660
	1974	1260	2040	2360	5660
	1975	1360	1540	1640	4540
	1976	1480	2780	--	4260
	1977	2290	2510	2910	7710
	1978	2240	2660	970	5870
	Avg	2090	2390	1640	6120
5	1973	3860	2810	1380	8050
	1974	2760	1500	1500	5760
	1975	2780	960	1020	4760
	1976	2540	2200	--	4740
	1977	2980	1880	2260	7120
	1978	3840	2100	700	6640
	Avg313	3130	1910	1140	6180
least significant difference .05	1973	NS*	NS	160	--
	1974	106	332	172	--
	1975	100	72	154	--
	1976	280	130	---	--
	1977	138	95	130	--
	1978	150	160	70	--

*not significant

Table 2. The effect of top dressing upon the cation ratio (K/Ca+Mg) in tall fescue.+

Treatment		Spring Samplings				Fall Harvests		Samplings			Harvest
		1	2	3	4	1	2	1	2	3	3
1	1973	1.99	1.87	1.88	.82	1.39	.99	.93	1.01	--	.72
	1974	1.77	1.71	1.35	--	1.31	1.11	.61	.64	--	.62
	1975	1.48	1.46	1.50	1.41	1.59	.83	.61	.58	--	.57
	1976	1.31	1.25	1.25	--	1.30	.99	.78	.69	.77	--
	1977	1.04	1.09	1.14	--	1.60	1.01	.74	.87	--	.72
	1978	1.42	1.45	1.12	--	1.22	.72	.31	--	--	.38
2	1973	2.00	ND	ND	ND	1.42	1.08	ND	ND	--	ND
	1974	1.72	1.63	1.38	ND	1.30	1.08	.79	.86	--	.81
	1975	1.51	1.45	1.50	1.40	1.50	.79	.79	.77	--	.74
	1976	1.21	1.15	1.21	--	1.23	.91	.97	.85	1.01	--
	1977	1.06	1.02	1.14	--	1.51	.95	1.01	1.08	--	.87
	1978	1.54	1.37	1.13	--	1.22	.73	.49	--	--	.48
3	1973	ND	ND	ND	ND	1.36	1.02	ND	ND	--	ND
	1974	1.51	1.48	1.22	--	1.27	1.19	.76	.89	--	.84
	1975	1.42	1.35	1.41	1.40	1.45	.96	.79	.70	--	.75
	1976	.95	1.03	1.19	--	1.10	1.16	.96	.85	1.03	--
	1977	.90	1.01	1.07	--	1.38	1.18	1.02	1.14	--	.89
	1978	1.64	1.51	1.16	--	1.23	.87	.52	--	--	.54
4	1973	1.86	1.65	1.76	.84	1.26	1.02	1.09	1.07	--	.73
	1974	1.41	1.27	1.12	--	1.16	1.30	.64	.72	--	.69
	1975	1.32	1.24	1.29	1.29	1.35	1.10	.71	.69	--	.71
	1976	.93	1.03	1.12	--	1.04	1.26	.81	.73	.82	--
	1977	.81	.91	.94	--	1.20	1.33	.84	1.00	--	.81
	1978	1.53	1.33	.98	--	1.06	1.00	.39	--	--	.49
5	1973	ND	ND	ND	.99	1.24	1.10	1.08	1.14	--	.71
	1974	1.65	1.57	1.33	--	1.23	1.21	.60	.66	--	.57
	1975	1.40	1.36	1.33	1.29	1.38	.98	.66	.62	--	.57
	1976	1.12	1.07	1.09	--	1.16	1.20	.81	.77	.85	--
	1977	1.00	.98	1.04	--	1.39	1.18	.81	.91	--	.68
	1978	1.47	1.31	1.01	--	1.13	.83	.33	--	--	.35
least significant difference‡ .05	1973	NS	.18	NS	NS	.12	NS	NS	NS	--	.35
	1974	.07	.097	.08	--	.07	.06	.065	.082	--	.06
	1975	.068	.05	.078	.076	.116	.044	.073	.060	--	.065
	1976	.081	.08	.07	--	.075	.092	.051	.068	.076	--
	1977	.069	.069	.059	--	.10	.072	.067	.067	--	.056
	1978	.09	.08	.05	--	.09	.06	.04	--	--	.04

+In 1973 chemical analysis of many of the samples was not done; these entries are designated "ND" ie. not determined. Cells in this table which contain a dash (-) indicate samplings or harvests which were not made.

‡The least significant difference values apply only to treatment means within a given year and sampling or harvest.

SOILS OF SOUTHWESTERN MISSOURI

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Department of Agronomy

ABSTRACT: Three soils, Gerald, Creldon and Keeno, make up a large portion of the gently sloping uplands of the Southwest Research Center. Similar Soils are distributed over a wide area of Southwestern Missouri. The soils have special features that influence plant rooting and yield. All three soils have fragipans (dense layers) in the lower subsoils that are extremely acid. Root penetration is believed to be restricted by such layers. Cherty (stony) layers in the Creldon and Keeno soils result in low volumes of available moisture storage in subsoils.

Soils of the University of Missouri Southwest Research Center have features that relate them to a large area of Missouri delineated on the map in Figure 1. Claypan horizons in some soils relate them to many soils to the west and north of the center. Underlying limestones, contents of chert fragments and fragipans in other soils relate them to many soils east and north of the center.

There are more than 20 different kinds of soils on lands of the Southwest Research Center. They may be grouped into three topographic units: (1) the alluvial lands along Spring River; (2) the sloping, formerly forested lands bordering the Spring River Valley; and (3) the gently sloping prairie uplands.

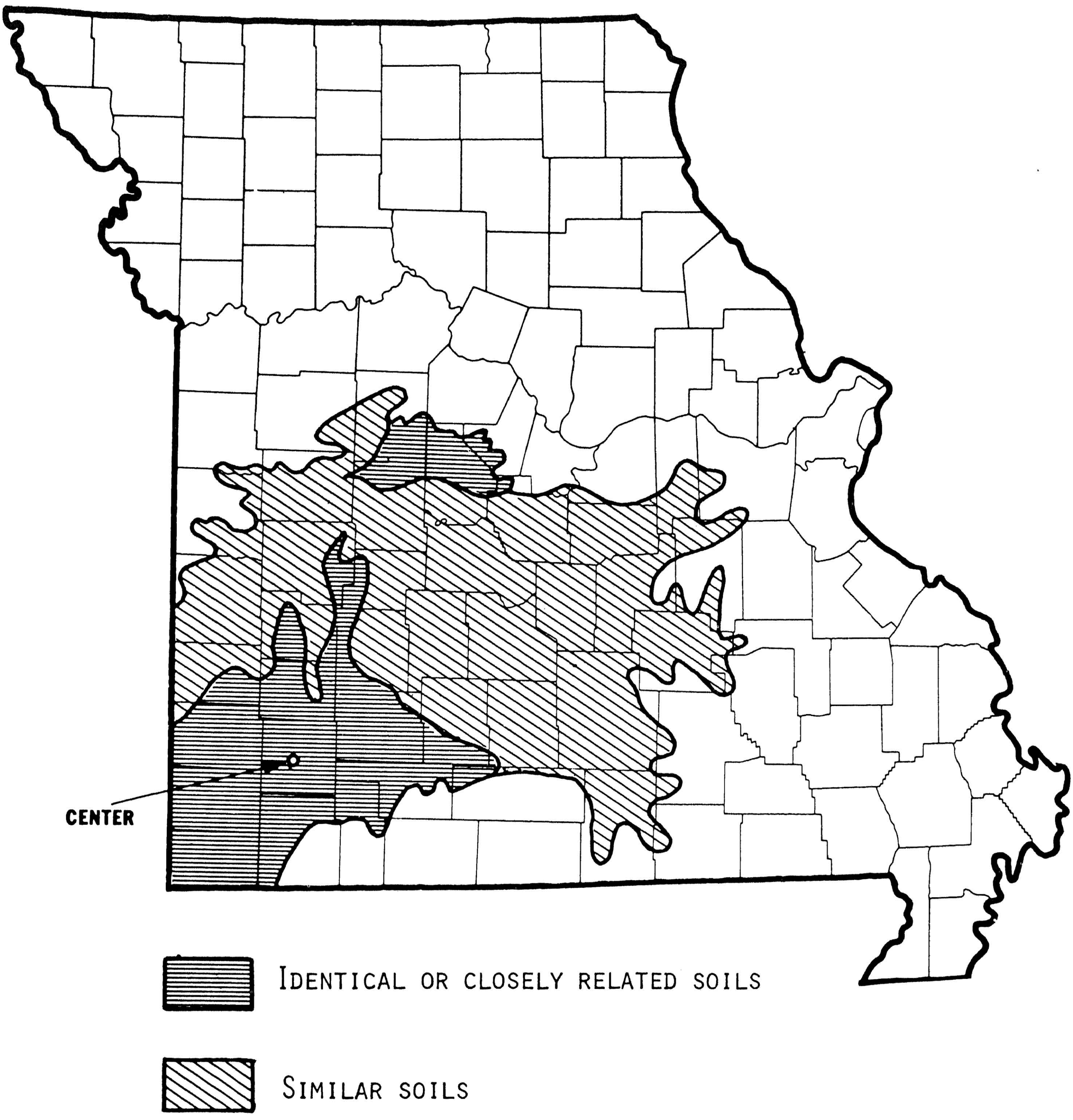
Three soils of the gently sloping prairie uplands were studied in detail. Those soils, named the Gerald, Creldon and Keeno form most of the landscape on the western portion of the lands of the Center. Those same soils are prominent parts of the landscape in that part of Missouri shown in Figure 1 to have identical or closely related soils.

Gerald, Creldon, Keeno Soils

This group of soils forms a pattern (called a soil association) in which the Gerald is positioned on nearly level to depressional parts of the landscape. The Creldon and Keeno soils are on slopes with gradients of 2 to 12 percent. Within the association there are several features that are important in soil-plant relationships. Those special features are:

FIGURE 1.

MISSOURI AREAS WITH SIMILAR SOIL CONDITIONS TO THOSE OF THE UNIVERSITY OF MISSOURI-COLUMBIA SOUTHWEST CENTER.



Claypans	-	Subsoils with high clay content - a feature of Gerald soils.
Fragipans	-	Dense and compact layers in lower subsoils - a feature in all three soils
Cherty Layers	-	Layers with 10 to 80 percent of the volume made up of coarse chert - a feature of Creldon and Keeno.
Acid, Infertile Subsoils	-	pH of 4.0 or less; low phosphorus and potassium - a feature of all three soils.

Plant root penetration and function may be affected by the special soil features in three ways; (1) water storage capacities are affected, (2) densities of fragipans are great enough to retard root penetration and (3) the pH of the subsoils is low enough to suggest a possible interference from aluminum, manganese and other elements in the chemical nutrition of the roots.

Plant Available Water Storage Capacities

The amount of water which the soils can store and release to growing plants is greatly affected by volumes of coarse chert which retain little or no water and by fragipans which have low pore volumes for water retention. Volumes of available water for the different soil layers are tabulated in Table 1. The volumes vary from 3 percent to 20 percent of the soil volume. When those volumes are converted to inches of water in given depths of soils they are as follows:

Soil	Plant Available Water Storage (in 3 ft soil)	(in 4 ft soil)
Gerald	5.4 inches	6.9 inches
Creldon	4.8	5.5
Keeno	3.5	3.9

The estimates of available water are based upon the assumption that roots can penetrate and function well to depths of three and four feet. It may be that the physical and chemical nature of the fragipan prevents some penetration and thus not all of the water may be truly available.

Densities of Fragipans

Data included in Table 1 show that the fragipan layers are compacted to densities of 1.55 grams/cc. Some more strongly expressed fragipans in the Missouri Ozarks may have densities as high as 1.8 grams/cc. Thus the fragipans are not as dense in the Gerald, Creldon, Keeno soils as they are in some soils in Missouri. Even so a density of 1.55 indicated a soil with only 40 percent pore space for retention of water and for root penetration. Root penetration is generally believed to be retarded at densities greater than 1.5.

Subsoil pH or Acidity

Data included in Table 1 show that minimum pH values exist in the fragipans of the Creldon and Keeno soils where minimum values are pH 3.65 and pH 3.95. Such values are extremely low. Research has not been performed to demonstrate impeded root growth in these soils associated with low pH. However, they are in the range at which aluminum and manganese toxicities are possible.

Phosphorus levels of the subsoils are extremely low. Test values of 6 to 18 pounds per acre 7 inches of soil are common. Similar depths in many northern Missouri soils have phosphorus test values of over 200 pounds per acre seven inches of soil. Potassium and calcium levels are also low.

Possible Remedies for Subsoil Features

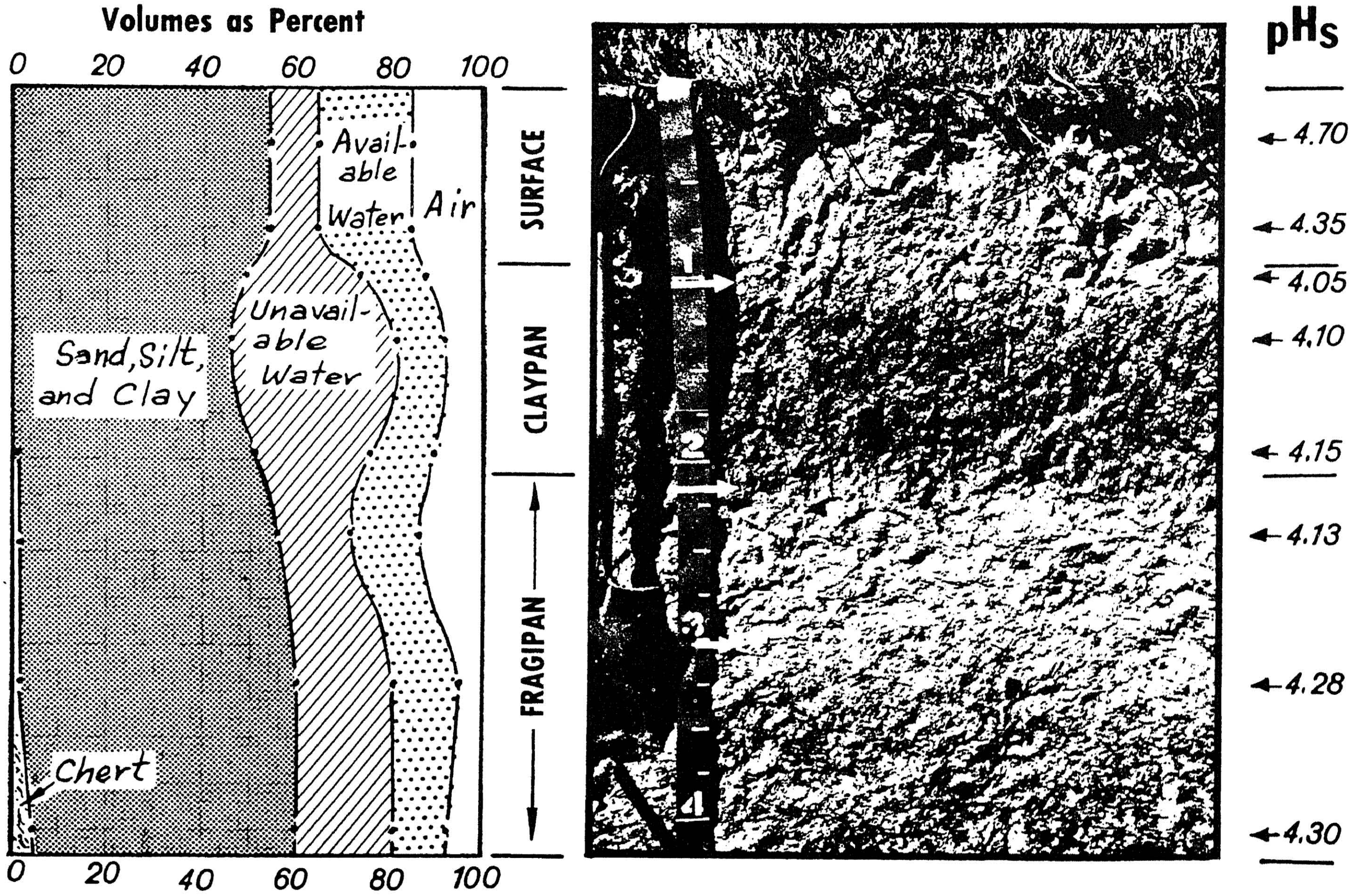
Research may be needed to determine the effects upon root penetration that will result from physical and chemical alterations of the fragipan. Conventional methods cannot be employed. However, the fragipan layers could be mechanically broken by chiseling or they could be mechanically mixed with overlying or underlying horizons having more clay. For example, if the claypan horizon of the Gerald could be mechanically mixed with the upper one foot of the underlying fragipan, the resulting mixture would have a clay content of 36 percent. Swelling and shrinking of the clay would prevent reformation of the dense fragipan. The available water holding capacity of the upper 3 feet of soil would be increased by about ten percent.

Liming of the subsoils concurrent with mechanical mixing or chiseling might raise the subsoil pH above a critical level and thus encourage root penetration.

The Creldon and Keeno soils could possibly be greatly charged by the above procedures. The fragipans are thin; the underlying materials have low densities and slightly higher pH's. Thus the destruction of the rooting barrier presented by the fragipan might result in a greatly enlarged rooting volume extending well below the present bottom of the fragipan.

Figure 2.

GERALD SOIL
UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Gerald soils have dark colored, silty surface horizons underlain by claypan horizons which have as much as 50 to 60 percent clay sized particles. They have fragipans (dense acid layers) below the claypan. Some small chert fragments are scattered throughout materials below the claypan and at some depth (usually over four feet) red cherty clay materials are found. The silty surface soil and the claypan are thought to have formed in a silty, wind laid deposit called loess. The cherty materials formed as the result of weathering of cherty limestones which underlay the soil areas.

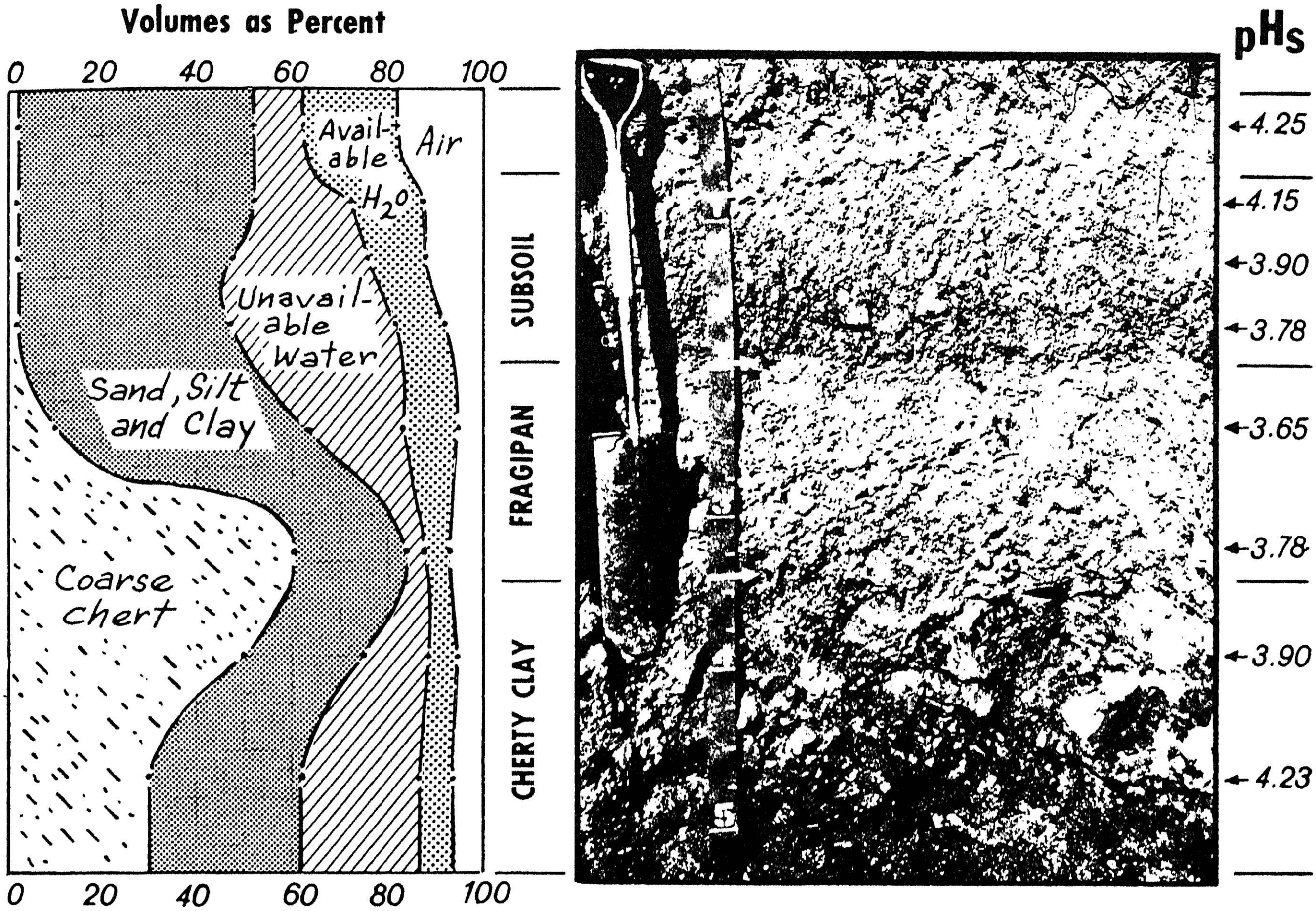
The claypan horizon retains large volumes of unavailable water and causes some restriction in drainage and aeration in spring months. The fragipan horizon is not as dense as those of the central and eastern ozarks. However, density of 1.55 grams/cc. is enough to impede root penetration. The fragipan horizon is not present in other claypan soils north of the Gerald areas.

Available water storage capacities are moderate, being 5.4 inches in 3 feet of soil or 6.9 inches in 4 feet of soil.

Figure 3.

CRELDON SOIL

UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Creldon soils have dark silty surface soils and brown, silty clay subsoils that are underlain by dense, cherty fragipan layers. Volumes of coarse fragments and the dense fragipan severely limit volumes for penetration of air, water and roots below two feet depth.

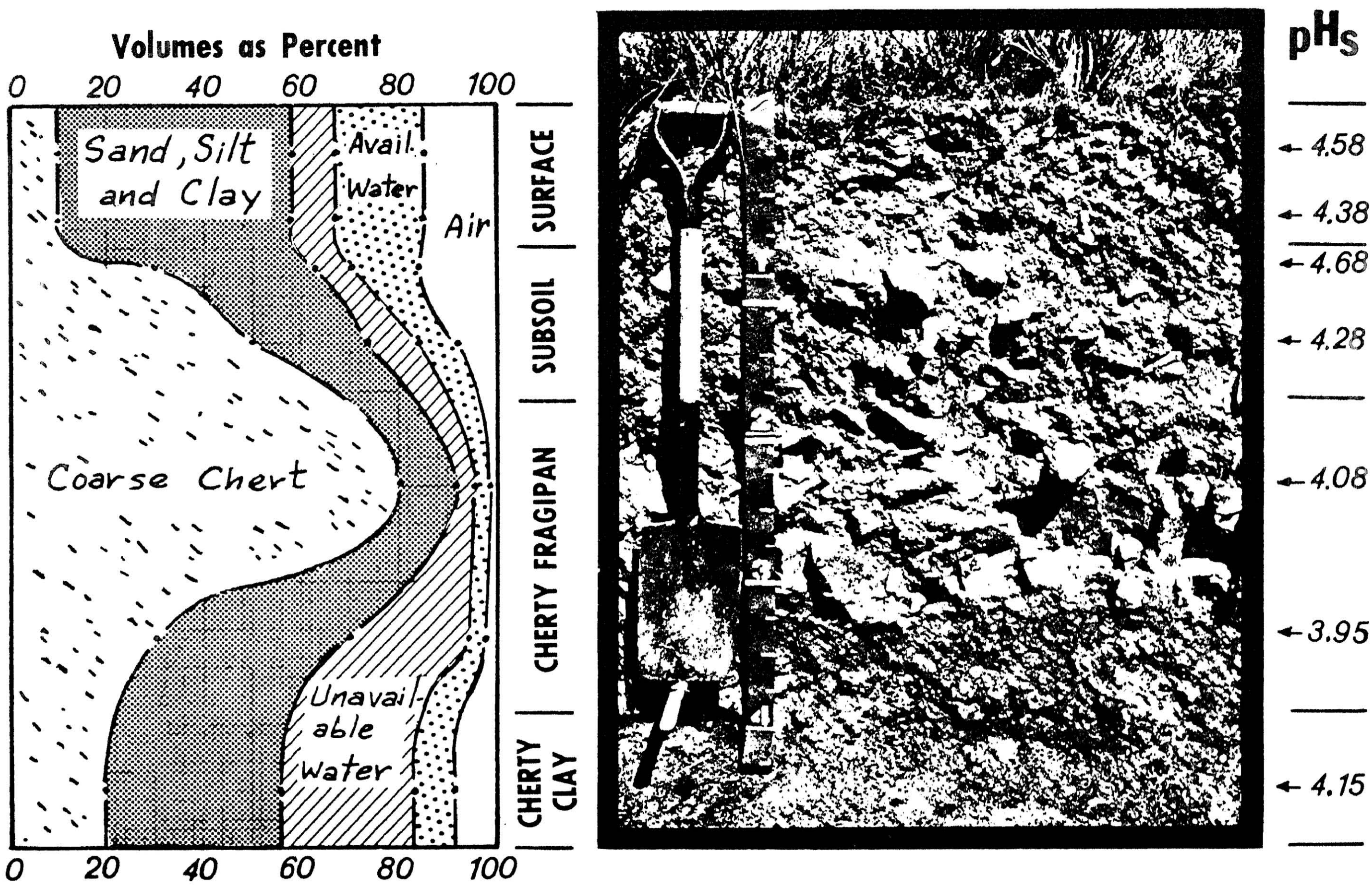
Available water storage capacity is 4.8 inches of water in 3 feet of soil and 5.5 inches of water in 4 feet of soil. These low capacities result in early drought damage to crops during periods of rainfall shortage.

The fragipan and subsoil are extremely acid and may present chemical barriers to root penetration.

Some of the Creldon soils on Southwest Research Center lands are slightly less well drained than is typical for the soil in other parts of Missouri.

Figure 4. **KEENO SOIL**

UNIVERSITY OF MISSOURI - COLUMBIA, SOUTHWEST CENTER



The Keeno soils are characterized by large volumes of chert. They have dark-colored cherty silt loam surface horizons and have cherty fragipans at two to three feet depth.

Available water storage capacities are low being 3.5 inches of water in 3 feet of soil and 3.9 inches of water in 4 feet of soil.

The cherty fragipan is extremely acid and the root environment in that layer is poor both chemically and physically. Materials below the fragipan are red cherty clays with moderate to low densities and they are less acid than the overlying fragipan.

Cherty limestone underlies the soil at variable depths.

Table 1. Some characteristics of Three Soils - University of Missouri Southwest Center

Soil Name	Depth (inches)	Nature of Fine Earth (Total Soil Minus Coarse Chert)			Volumes of Solids and Water (Percent of Total Soil)				
		pH_s	Clay Content (%)	Bulk Density (%)	Coarse Chert (%)	Sand, Silt and Clay (%)	Water 1/3 Atm.* (%)	Water 15 Atm.* (%)	Water Avail.* (%)
Gerald	0- 7	4.70	13	1.44	0	54	30	10	20
	7-11	4.35	15	1.42	0	54	30	10	20
	11-13	4.05	39	1.30*	0	49	38	24	14
	13-22	4.10	55	1.21	0	46	45	35	10
	22-25	4.15	35	1.32	1	50	38	24	14
	25-33	4.13	19	1.46	2	54	30	15	15
	33-44	4.28	29	1.55	2	58	34	21	13
	44-52	4.30	27	1.53	5	55	32	21	11
	52-62	4.40	32	1.51	10	51	28	20	8
Creldon	0- 7	4.25	15	1.36	2	50	30	10	20
	7-12	4.15	33	1.34	2	50	36	20	16
	12-16	3.90	40	1.24	2	46	40	28	12
	16-22	3.78	53	1.22	2	45	45	35	10
	22-34	3.65	32	1.55	10	53	32	20	12
	34-41	3.78	24	1.55*	60	24	9	4	5
	41-51	3.90	50	1.30*	50	25	20	14	6
	51-62	4.23	88	1.21	30	32	32	25	7
Keeno	0- 7	4.58	20	1.40*	10	48	27	9	18
	7-11	4.38	24	1.40*	10	48	27	9	18
	11-14	4.68	23	1.24*	30	33	21	7	14
	14-23	4.28	29	1.24*	50	24	18	10	8
	23-35	4.08	27	1.55*	80	12	7	4	3
	35-47	3.95	65	1.50*	30	40	28	25	3
	47-58	4.15	73	1.20*	20	36	36	28	8

*Estimated values

SMALL GRAIN RESEARCH

Calvin Hoenschell, Dale Sechler, J. M. Poehlman
Paul Rowoth and Tim Flanders

Small grains research at the Southwest Center involves wheat, barley, both spring and winter oats, and triticale. Variety trials of all the grains were grown in 1979-80 as well as breeding materials for selection and nurseries for insect and disease evaluation.

A replicated trial which included 29 commercially available varieties of wheat was grown in 1980. The performances of these varieties, developed by both public and private breeders, may be compared not only to each other but also to advanced experimental lines included in the trials. The consistent production of high yields of acceptable grain quality harvested with a minimum of difficulty is desired. Resistance to lodging, drought stress, shattering, pest problems, etc. contribute to consistency of performance and minimal production losses. Mildew, Septoria, leaf rust, and BYDV were problems that were evident in this nursery in 1980. Yields ranged from a low of 37 to a high of 81 bu/acre. In a similar nursery at Lamar, yields ranged from 33 to 61 bu/acre.

In addition to the above trial, 240 experimental lines of wheat were evaluated for their potential under the production situation in Southwest Missouri. Eighteen triticale selections were compared to the parental species, rye and wheat. In addition 50 bulk populations, hopefully segregating for new combinations of traits, were space planted and plant selections made. A uniform wheat nursery including differentials for the identification of hessian fly races was grown and sampled.

A replicated trial including forty spring oat lines was grown at the Center in 1980. Fifteen of these were commercially available varieties. There was minimal growth due to adverse weather conditions and yields were low ranging from a low of 33 bu/A to a high of 56. A winter oat trial, of forty entries, produced yields ranging from 72 to 123 bu/acre. Winter survival can be an important factor in the production of winter oats but almost no winterkilling occurred in 1980. Almost 200 winter oats observation rows were evaluated for their production potential.

Sixty varieties and/or experimental lines of two-and six-row winter barley were evaluated in 1980. Major emphasis in the breeding program has been on acceptable two-row varieties for malting but both two-and six-row parental types have been used. Yields were good ranging from 49.5 to 104.2 bu/acre in the test of six-row varieties and 62.5 to 97.8 bu/acre in the test of two-row varieties. No malt varieties are yet available that could be recommended for production in Southwest Missouri. Suitable six-row feed barley varieties, such as Perry, are adapted for production in the area.

Comparative performance and descriptions of wheat, oat, and barley varieties adapted to the area are available from extension personnel and are published in current UMC Agricultural Guides.

STORAGE LOSSES on LARGE ROLL and A.C. ROTO BALES

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Abstract: Alfalfa, fescue-lespedeza, and orchardgrass-lespedeza hay baled August 31, 1979 with Vermeer and OMC (Owatonna) large roll balers and an A.C. Roto baler was stored various ways outside or stored in an open barn. Dry matter storage losses ranged from 2 to 11 percent on the outside-stored hay and from 0.3 to 7 percent on the barn-stored large roll bales. A.C. Roto bales lost 9.2 and 21.6 percent dry matter on outside-stored alfalfa and fescue-lespedeza hays, respectively. Vermeer large roll bales tended to have lower dry matter storage losses than the OMC bales. However, the OMC-made bales cured out better than the Vermeer-made bales. Stacking Vermeer-made bales outside decreased dry matter losses of the top bales but increased dry matter losses in the bottom bales.

Introduction: The purpose of the following studies was to gather more information on storage losses for large roll bales stored outside and inside a barn and to measure storage losses on bales stacked outside. Storage losses of a soft core large roll bale (Owatonna), a dense bale throughout (Vermeer), and the small roll bale (A.C.) were also compared. 1/

Procedure: Three fields containing alfalfa, fescue-lespedeza, and orchardgrass-lespedeza were cut August 27,28, and 29, 1979, respectively. The hays were raked at the proper time to prevent leaf shatter and baled August 31, 1979.

The hays were baled simultaneously with a Vermeer Model 504F, an OMC (Owatonna) Model 595, and an Allis Chalmers Roto baler. The alfalfa hay received 2.45 inches of rain the day it was cut. The fescue-lespedeza and orchardgrass-lespedeza hay received no rain.

Results and Discussion:

ALFALFA HAY

The alfalfa hay bales were weighed and core sampled for moisture and quality the same day the bales were made. Percent moisture, protein, and NDF were 17.8, 16.45, and 64.82, respectively. One Vermeer and one OMC-made bale were stored inside and two bales from each baler were stored outside, individually, on discarded tires. All 12 of the Allis Chalmers Roto bales were stored outside on the ground. Results are summarized in table 1.

With the very small number of bales, only limited conclusions could be made. Dry matter storage losses were 3 to 5 percent higher for those bales held over from April to mid-July. Dry matter storage losses on alfalfa hay were not significantly different for Vermeer, OMC, and A.C. Roto bales stored outside until July 15.

1/ The authors wish to acknowledge Mr. Clovis Haubine and Mr. Mel Staubus who donated their time and machinery to bale our hay.

The large roll bales weathered one to three inches deep while the weathered layer on the A.C. Roto bales was less than one inch. The Vermeer bales turned brown about twelve inches out from the core and were moldy within six inches of the very center of the bale. The OMC bale fed in April did not brown or mold. This would indicate that balers making a very dense bale throughout should dry alfalfa hay below 18 percent moisture which was the moisture of the hay baled in this study.

FESCUE-LESPEDEZA HAY

The fescue-lespedeza hay contained more lespedeza than grass. At baling, percent moisture, protein, and NDF were 12.8, 13.75, and 66.56, respectively. Four bales each made with Vermeer and OMC balers were stored outside, butted end to end, on telephone poles. Nine bales made with the A.C. Roto baler were stored outside on the ground. Six bales were stored inside an open barn. Results are summarized in table 2.

Outside storage losses were very low with only 1.8 and 4.2 percent dry matter loss for the Vermeer and OMC-made bales, respectively. Both the Vermeer and OMC bales took on moisture between the bales and there were still wet spots between the bales when they were weighed in mid-July. Since core sampling does not pick up this moisture at the very ends of the bales, the dry matter losses are probably low. The weathered layer on bales from both balers was from 1 to 3 inches. One OMC bale was weathered to 6 inches near the one end of the bale. The OMC-made bales did appear to take on more water between the bales stored in rows end-to-end. This could account for the slightly greater storage loss on the OMC bales.

The A.C. Roto bales stored outside on the ground had a big 21.6 percent dry matter loss. It is unclear why the loss was so much higher than with the alfalfa hay.

The Vermeer bales stored inside appear to have a greater dry matter loss than those placed outside on poles. Because of the 1 to 3-inch weathered layer of the outside stored bales, the dry matter losses should be greater outside.

ORCHARDGRASS-LESPEDEZA HAY

The orchardgrass-lespedeza hay was the poorest of the three hays tested because it contained considerable trash and weedy grasses. Percent moisture, protein, and NDF measured 5 days after baling, at the time of storage, were 14.2, 9.63, and 75.52, respectively. The Vermeer and OMC-made bales were stored end-to-end on poles or individually on poles. Five Vermeer bales were stacked two bales high. Results are summarized in table 3.

Some of the bales were fed in late March and early April. Dry matter storage losses were 2 to 5 percent lower April 1st compared to bales stored until July 15th. Bale numbers were too small to make definite conclusions. However, the Vermeer-made bales tended to have lower outside storage losses than the OMC-made bales.

At the time of storage, a Vermeer bale and an OMC bale were noticeably hot. These two bales were unrolled July 15, 1980. The OMC bale was green to the center. The Vermeer bale unrolled to about 18 inches in diameter when the layers began sticking together and the hay turned from a pale green to a light brown color. The hay did not mold.

Five Vermeer bales were stacked two bales high. The bottom bales were set on end on discarded tires. The top bales were set on the rounded surface and butted end-to-end. The top bales had a low dry matter storage loss of 3 percent compared to 5.9 percent for bales stored on poles. The bottom bales had a 2 percent greater storage loss than bales stored on poles. The lower storage loss of the top bales was cancelled by the greater loss of the bottom bales. Stacking will save storage space but top bales must be carefully placed end-to-end and centered over the bottom bales to prevent water from penetrating the bottom bales.

Table 1. DRY MATTER STORAGE LOSSES ON ALFALFA HAY BALES MADE WITH VERMEER, OMC, AND A.C. ROTO BALERS.

Baler	No. of Bales	Bale Weight at Baling (lbs.)	Storage Method	Dry Matter Storage Loss to 4-1-80 (%)	7-14-80 (%)
Vermeer	1	870	Barn	1.8	
Vermeer	1	1015	Outside on tires	7.9	
Vermeer	1	915	Outside on tires		10.9
OMC	1	840	Barn		10.4 *
OMC	1	1200	Outside on tires	2.5	
OMC	1	1270	Outside on tires		8.2
A.C. Roto	12	44	Outside on ground		9.2

* Holstein heifers broke into barn twice and ate part of the hay.

Table 2. DRY MATTER STORAGE LOSSES ON FESCUE-LESPEDEZA HAY BALES MADE WITH VERMEER, OMC, AND A.C. ROTO BALERS.

Baler	No. of Bales	Bale Weight at Baling (lbs.)	Storage Method	Dry Matter Storage Loss to 4-1-80 (%)	7-16-80 (%)
Vermeer	4	935	Outside on poles		1.8
OMC	4	1301	Outside on poles		4.2
A.C. Roto	9	43.5	Outside on ground		21.6
Vermeer	2	962	Inside barn		7.1
Vermeer	2	902	Inside barn	3.4	
OMC	1	1275	Inside barn		9.9 *
OMC	1	1290	Inside barn	0.3	

* Holstein heifers broke into barn and ate part of the bale.

Table 3. DRY MATTER STORAGE LOSSES ON ORCHARDGRASS-LESPEDEZA HAY BALES MADE WITH VERMEER AND OMC BALERS.

Baler	Bale Weight at Storage	Number of Bales	Storage: Individual	Storage: End-to-end	Stacked: Bottom Bales	Stacked: Top Bales	Dry Matter Storage Losses 4-1 1980 (%)	Dry Matter Storage Losses to 7-14 1980 (%)
OMC	1420	1	X				4.4	
Vermeer	1090	1	X				2.8	
OMC	1365	3		X				9.8
Vermeer	1015	2		X				5.9
Vermeer	990	1		X			3.8	
Vermeer	1017	3			X			8.1
Vermeer	1028	2				X		3.0

HAY QUALITY of LARGE ROLL BALES

S. Bell, Southwest Missouri Research Center
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Introduction:

Two recent reports (1,2,) have been written on dry matter storage and feeding losses using large roll bales. The following is an update on the quality losses of the forages used in those studies.

1978 Research Report - ORCHARDGRASS-LADINO-RED CLOVER HAY 1/

The orchardgrass-clover hay was cut May 23, 1977 and baled with a New Holland Model 850 baler. The bales stored outside received 36 inches of rain between baling and feeding in March of 1978. Quality losses will vary from year to year with changes in rainfall and the depth of moisture penetration into the bales. Moisture penetrated 8 to 12 inches into the bales stored outside in this study. Results are summarized in Table 1.

Results show that NDF (neutral detergent fiber), ADF (acid detergent fiber) and cellulose increase during storage even in those bales placed inside barns. An increase in any of these measurements indicates that the more soluble and digestible parts of the hay are being leached out, oxidized, or used up by molds and bacteria. Therefore, the higher the percentages of NDF, ADF, and cellulose, the lower the quality and digestibility of the hay.

Protein content of the hay after 10 months storage in a barn decreased 3 tenths of 1 percent. The 18 percent increase in protein content of the weathered layer gives a false impression of increased quality. The palatibility, digestibility, and energy value of that layer is lower because the more soluble parts are leached out.

The net energy for maintenance decreased 6.9 percent between the barn and the outside stored hay. If you separate off the 12-inch weathered layer, it was 17.2 percent lower in energy than the barn-stored hay.

1979 Research Report - SWITCHGRASS HAY 2/

The switchgrass hay was cut June 12, 1978 and baled with a New Holland Model 850 and a Hesston Model 5800 baler. The bales received 50 inches of rain during 13 months of storage. Quality comparisons are summarized in Table 2.

1/ Storage and Feeding Losses of Large Roll Bales. S. Bell, F.A. Martz; Research Reports 1978, 72-77, Univ. of Missouri, SW Center

2/ Large Roll Bale Storage Losses on Switchgrass Hay. S. Bell, F.A. Martz; Research Reports 1979, 45-47, Univ. of Missouri, SW Center

The New Holland bales weathered more than the Hesston bales in this study (2) and this is reflected in the increased percentages of NDF, ADF, and cellulose. The protein content usually rises as more of the water soluble nutrients are weathered out of the outer layers of the bales. The net energy decreased the same for both the New Holland and the Hesston bales.

Part of the weathering process is molds, fungi, and bacteria growing and eating away at the more soluble carbohydrates in the bales. The cell walls of these micro-organisms contain chitin, a poly-glucosamine, which does not appear in uninfected plant tissue. By measuring the amount of glucosamine (chitin) in the bales, we can estimate the amount of cell walls of micro-organisms present. The switchgrass hay bales were sampled at 0-8", 8-11", and 16-24" with a Penn-State forage sampler. In Vitro dry matter digestibility (IVDMD) was also measured. Results are summarized in Table 3.

Levels of chitin were four to six times higher in the 0-8" layer of the outside-stored hay compared to barn-stored hay. Digestibility decreases as chitin increases.

The decrease in digestibility with increased chitin is greater in higher quality hays. Therefore, higher dry matter and nutritive losses can be expected on high quality hay bales weathered similar to lower quality hay bales.

Table 1. NDF, ADF, CELLULOSE, PROTEIN, AND NET ENERGY CHANGES ON ORCHARDGRASS-CLOVER HAY STORED 10 MONTHS INSIDE OR OUTSIDE.

Quality Factor	Date	Storage	No. of Bales	Quality Percentage	Change From Time Baling * %
NDF	6-3-77	at baling	18	62.05	
ADF			18	38.84	
Cellulose			18	32.56	
Protein			18	12.68	
NDF	3-78	Inside	6	67.53	+ 8.8
ADF			6	39.17	+ 0.8
Cellulose			6	34.68	+ 6.5
Protein			6	12.64	- 0.3
NE			6	.58	
NDF	3-78	Outside	14	68.96	+ 11.1
ADF			14	42.98	+ 10.6
Cellulose			14	34.69	+ 6.5
Protein			14	12.18	+ 1.8
NE			14	.54	- 6.9
NDF	3-78	Outside unweathered core	3	68.97	+ 11.2
ADF			3	42.84	+ 10.3
Cellulose			3	35.89	+ 10.2
Protein			3	13.69	+ 8.0
NE			3	.54	- 6.9
NDF	3-78	Outside weathered layer	4	79.29	+ 27.8
ADF			4	48.89	+ 25.9
Cellulose			4	37.40	+ 14.9
Protein			4	14.96	+ 18.0
NE			4	.48	- 17.2

* Changes in Net Energy for maintenance compared to the inside stored hay.

Table 2. NDF, ADF, CELLULOSE, AND PROTEIN OF SWITCHGRASS HAY AFTER 13 MONTHS STORAGE INSIDE OR OUTSIDE.

Quality	Barn Stored	Outside Stored Hesston	Decrease or Increase over Barn Stored %	Outside Stored New Holland	Decrease or Increase over Barn Stored %
No. of Bales	6	6		6	
NDF	76.67	78.99	+ 3.0	80.95	+ 5.6
ADF	41.39	42.74	+ 3.3	43.08	+ 4.1
Cellulose	36.15	39.06	+ 8.0	40.04	+ 10.8
Protein	9.79	12.12	+23.8	11.45	+ 17.0
NE Maint.	.45	.41	- 8.9	.41	- 8.9

Table 3. CHITIN AND IVDMD OF SWITCHGRASS HAY AT 3 DEPTHS IN HESSTON AND NEW HOLLAND LARGE ROLL BALES STORED INSIDE AND OUTSIDE.

Baler	Storage	Sample Depth	No. of Bales	Chitin µg/gm	No. of Bales	IVDMD
Hesston	Outside	0-8 "	9	388.6	4	46.02
Hesston	Outside	8-16"	9	115.56	2	46.18
Hesston	Outside	16-24"	9	95.52	3	49.08
Hesston	Barn	0-8 "	3	76.73		
Hesston	Barn	8-16"	3	67.62		
Hesston	Barn	16-24"	3	79.78		
Hesston	Barn	0-24"	1	80.85		
New Holland	Outside	0-8 "	9	494.51	5	44.23
New Holland	Outside	8-16"	9	169.31	3	46.99
New Holland	Outside	16-24"	9	105.81		
New Holland	Barn	0-8 "	1	96.5	1	47.30
New Holland	Barn	8-16"	1	83.5		
New Holland	Barn	16-24"	1	82.15		
New Holland	Barn	0-24"	3	94.85		

BEEF PRODUCTION ON TALL FESCUE AND TALL FESCUE-LEGUME PASTURES

A.G. Matches, R.E. Morrow,
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SUMMARY

In grazing trials at the Agronomy Research Center, the three year average shows that production of beef from tall fescue-legume pastures will equal or exceed animal production from tall fescue pastures which are annually fertilized with 125 lb N/A at a cost of near $31.00/A. Average daily gain (ADG) of Hereford x Angus steers was 31% greater on 'Kentucky 31' tall fescue pastures sod-seeded with 'Empire' birdsfoot trefoil or 'Kenstar' red clover as compared to tall fescue grown alone and fertilized with 125 lb N/A. Cattle gains per acre were not statistically different among nitrogen fertilized fescue and fescue-legume pastures. This experiment shows the benefit of legumes to animal performance under grazing conditions.

INTRODUCTION

A world population of 6.5 to 7.0 billion is expected by the end of this century. As a result of population increase accompanied by greater per capita demand of agricultural products, increased world food needs are projected to range from 45 to 50% by 1985 and to over 100% by the year 2000. (Hodgson 1975, '76 and '77).

Future demands for ruminant animal products are expected to remain high, but less grain is likely to be available for cattle feeding. Therefore, increased demands will be placed upon forages to replace the digestible energy lost through reduced grain consumption by livestock.

In view of expected changes in beef production anticipated in future years, the Missouri Agricultural Experiment Station was awarded a competitive grant by the U.S. Department of Agriculture to investigate the feasibility of producing forage-fed beef. This project began in 1977 and only grazing results from the Agronomy Research Center (ARC) are reported here. Results from other contributing experiments are reported elsewhere in this 1980 Progress Report on Beef Cattle Production and Management.

Objectives of the ARC grazing trials were (1) to compare the effects of nitrogen fertilized tall fescue pastures _vs._ tall fescue-legume pastures on spring through autumn steer gains and carcass composition and (2) to determine the influence of pasture type on steer performance on pasture and in the finishing phase. Only steer gain and pasture sward data from 1977 through '79 are presented here. Other reports include data on finishing and meat quality.

PROCEDURE

Legume Seedings: Empire' birdsfoot trefoil and 'Kenstar' red clover were interseeded into established stands of 'Kentucy 31' tall fescue on March 23-24, 1977. Rates of seeding were 7 lb/A for trefoil and 8 lb/A for red clover. Some pastures received partial seedings of trefoil each spring to help improve stands. Red clover was broadcast seeded in all pastures again in March, 1979.

Pasture Fertilization: Prior to seeding legumes in 1977, all pastures received a broadcast application of 3 T/A of agricultural limestone and 60 lb/A each of P_2O_5 and K_2O. Soil tests indicated that no additional phosphate or potash was needed in 1978. In April 1979, a 0-30-60 fertilizer was applied to all pastures.

Only the straight tall fescue pastures were fertilzed with nitrogen. The fertilization rate was 75 lb N/A in early spring (March-April) and 51 lb N/A in August. Because of severe drought and expected termination of grazing in September, the August 1979 application of nitrogen was not made.

Cattle And Grazing Management: Uniform groups of Hereford x Angus and reciprocal cross steers were purchased from Missouri producers in about mid-October of each year. Cattle were wormed, vaccinated, treated for warbles and lice, implanted, tagged, branded and analyzed for body composition with the ^{40}K whole body counter. They were overwintered on pastures of stock-piled tall fescue and steers had access to small-round bales of spring cut fescue which were left in the pasture. Generally, grain and protein supplement was provided from January on.

In the spring, steers were wormed and then assigned to pasture treatments by blocking so that group means for weight, frame and percent fat were nearly equal on each pasture. Six tester steers were assigned to each pasture. Pastures were arranged in a randomized complete block design with three replications.

Six acre pastures were rotationally grazed in a two paddock rotation in 1977 and in a four paddock rotation in 1978 and '79. Extra steers were used as put-and-take animals to maintain the desired levels of pasture utilization among treatments. Adjustments in animal number were made only 1 to 4 times per season.

Cattle were weighed at approximately 28 day intervals following 16 hours confinement in holding pens without feed or water. Cattle had access to trace mineral salt in all pastures. Also, moveable cattle shades were present in each pasture.

RESULTS

Dates of grazing for each grazing period are given in Table 1. Grazing began in April of each year and terminated on September 19, 28 and October 1 for 1977, '78 and '79, respectively. Over the three years, there was a range of from 158 to 165 calendar days of grazing.

The three year averages for pasture production data (Table 2) reveal several intersting trends. Average initial steer weights were the same, but there were considerable differences in ending weight. Steers on the fescue-legume pastures gained from 36 to 42 lbs more than steers on straight fescue. However, steer days of grazing per acre for fescue alone were 230 as compared to 202 on fescue-red clover and 188 on fescue-trefoil. Gains per acre were not statistically different among pasture types. Thus, fescue-alone pasture yielded more animal days of grazing, but fescue-legume pastures compensated with higher average daily gains (ADG) so that the product of steer days/A x ADG gave nearly the same amount of liveweight gain per acre.

Production data for individual years (Table 3) were very similar. Fescue-legume pastures always had significantly higher ADG's than fescue alone. Gains from fescue-trefoil and fescue-red clover pastures were similar each year except in 1979 when fescue-trefoil had better gains.

Red clover stands were good in the spring of 1979, but by June, most of the red clover had died because of drought and hot weather. Consequently, after grazing period 3, the ADG's on fescue-red clover began to follow the trends of steers grazing straight fescue. Plots of ADG for each year are shown in Figues 1, 2 and 3. In the first two years, ADG's trends on fescue-red clover were more similar to those for fescue-trefoil. Ranges in percent legumes as a percentage of available forage (botonical composition) and as number of plants (stand) varied greatly within a grazing season and among years (Table 4). Generally, legumes begin to harden-off for winter in late summer and autumn. During this process, there is less vegetative growth but roots begin to accumulate carbohydrates which are essential for winter survival.

The ADG's, especially in the late grazing periods for 1977 and '78, reflect the above changes in legume plant morphology. Autumns fescue-legume pastures could be typified as having lower percentages of legumes as compared to pastures in the spring and summer. The ADG trends also show that legumes with fescue help hold up animal gains during the summer (June-Aug). Rarely did we have favorable steer gains with fescue alone during the summer grazing periods.

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Table 1. Grazing Period Dates and Total Days of Grazing in 1977, '78 and '79 at the Agronomy Research Center.

Grazing Period	Dates of Grazing		
	1977	1978	1979
1	4/11-5/17	4/23-5/17	4/20-5/16
2	5/17-6/14	5/17-6/14	5/16-6/13
3	6/14-7/12	6/14-7/12	6/13-7/11
4	7/12-8/9	7/12-8/9	7/11-8/8
5	8/9 -9/19	8/9 -9.6	8/8 -9/5
6	---	9/6-9/28	9/5 -10/1
Total Days of Grazing	160	158	165

Table 2. Three year average (1977-'79) for average daily gains of steers, total beef production and other measurements on three types of pastures at the Agronomy Research Center.

Item	Pastures		
	Fescue grown alone	Fescue & red clover	Fescue & trefoil
Avg. initial wt (lb)	532	533	529
Avg. ending wt (lb)	669	706	710
Days of grazing	161	161	161
Tester steer days/A	230	187	168
Liveweight gain/A (lb)	193	202	188
Avg. daily gain (lb)	0.84	1.08	1.12
Avg. gain/steer (lb)	137	173	181

Table 3. Average daily gain of steers, total beef production and other measurements on three types of pastures at the Agronomy Resarch Center in 1977, '78 and '79.

Item	Pastures: Fescue & nitrogen	Fescue & red clover	Fescue & trefoil
		1977	
Avg. initial wt. (lb)	543	548	532
Avg. ending wt. (lb)	679	733	709
Days of grazing	160	160	160
Tester steer days/A	239	200	180
Liveweight gain/A	206	228	198
Avg. daily gain (lb)	0.86	1.14	1.10
Avg. gain/steer (lb)	136	185	177
		1978	
Avg. initial wt (lb)	524	510	524
Avg. ending wt. (lb)	645	676	690
Days of grazing	158	158	158
Tester steer days/A	230	182	159
Liveweight gain/A	172	193	169
Avg. daily gain (lb)	0.75	1.06	1.06
Avg. gain/steer (lb)	121	166	166
		1979	
Avg. initial wt. (lb)	530	541	531
Avg. ending wt (lb)	684	708	731
Days of grazing	165	165	165
Tester steer days/A	223	178	165
Liveweight gain/A (lb)	205	180	200
Avg. daily gain (lb)	0.92	1.01	1.21
Avg. gain/steer (lb)	154	167	200

Table 4. Range in legume stands and botanical composition of the tall fescue and legume pastures at the Agronomy Research Center in 1977-'79.

Pastures[1/]	Range in Percent Legumes 1977	1978	1979
	%	%	%
Tall fescue + Red clover stand (plant frequency)	13-36	18-25	0.2-15
Botanical Composition	14-23	3-12	2-16
Tall Fescue + Trefoil Stand (plant frequency)	7-19	17-19	1-18
Botanical Composition	20	3-6	7-14

[1/] Stands were determined with a point quadrat (200 points/pasture) and botanical composition was determined by hand separation of forage samples and reported on a dry weight basis. Both determinations were taken during the spring, summer and autumn of each year.

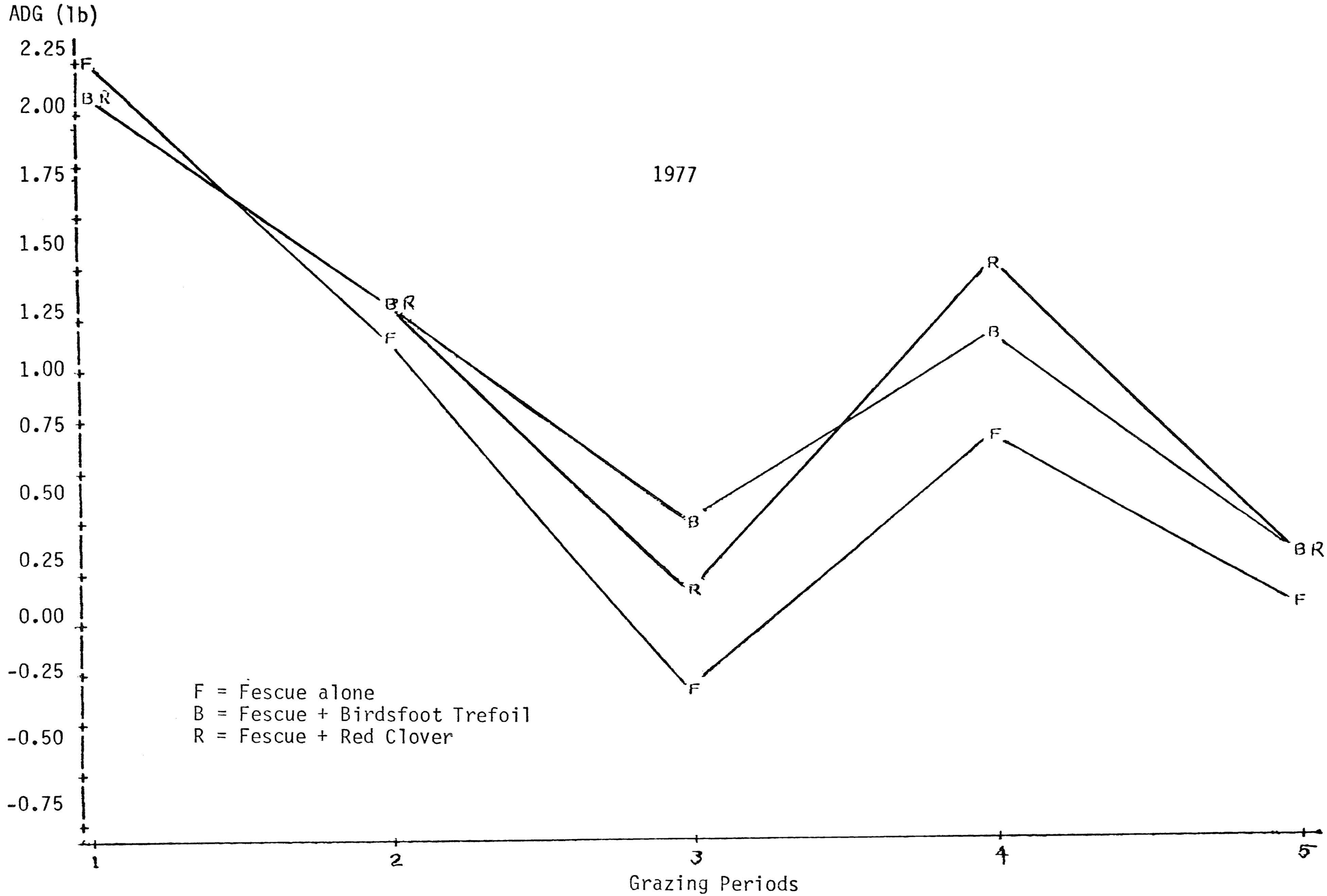

Figure 1. Average daily gain of steers in 1977.

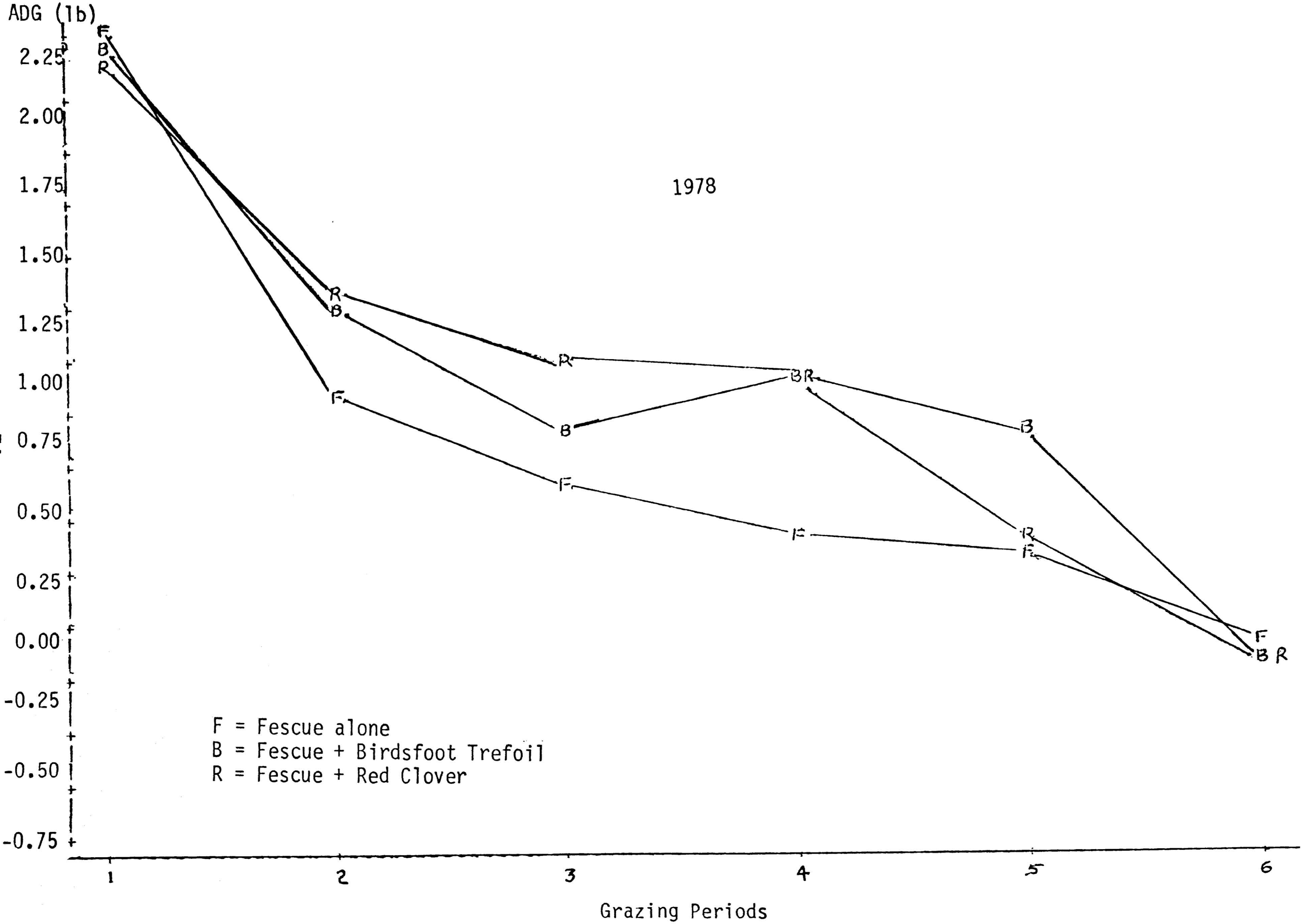

Figure 2. Average daily gain of steers in 1978.

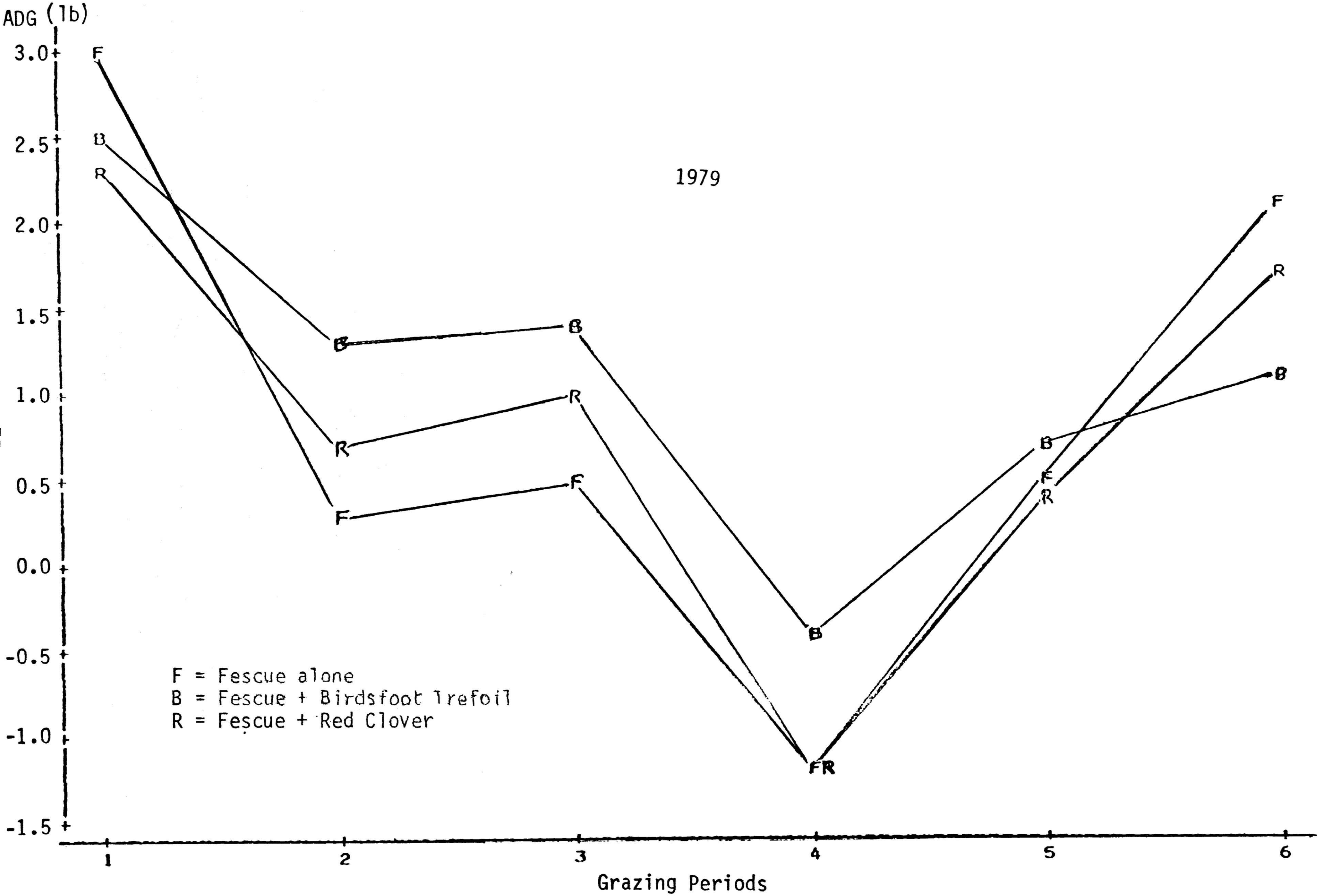

Figure 3. Average daily gain of steers in 1979.

COMPARISON OF PASTURE VS. FEEDLOT PRODUCTION SYSTEMS FOR FINISHING BEEF CATTLE

J.A. Paterson, D.K. Bowman, R.E. Morrow, H.B. Hedrick, G. Matches, R. Finley, and J. Thomas

SUMMARY

Results from a three year study comparing animal performance and days on feed from differing beef cattle production systems are presented. Four growing and finishing systems were selected which varied in the amount of total body weight produced with differing forage-grain inputs. Steers were slaughtered at weights of 850, 950, and 1050 pounds. Steers fed in a two phase corn silage-corn grain finishing system required less days to slaughter weight than did systems where steers were first backgrounded on stockpiled pasture followed by summer grazing and then fed corn on pasture.

Steers grazing summer fescue grass: red clover legume pastures gained 28% faster than did steers grazing fescue grass alone. Rate and efficiency of gains for steers fed a corn grain finishing diet in the feedlot were also evaluated after steers had grazed summer fescue, fescue: red clover, or fescue: birdsfoot trefoil pastures. Steers that had previously grazed fescue only pastures had a better rate and efficiency of gain than did steers that had grazed fescue: legume pastures.

INTRODUCTION

Increasing world population is expected to accelerate demand for both cereal grains and meat products. The feeding of cereal grains to beef cattle is a production component that has come under question in recent years. Because of this, researchers are challenged to continually improve the efficiency of both forage and grain utilization.

Consumer demand for beef products that have eye appeal, tenderness, juiciness, and flavor has caused livestock producers to evaluate different production programs that vary forage-grain inputs as well as length of feeding interval. Consumers find unacceptable cuts of meat with excessive fat content. However, beef packers have traditionally discriminated against pasture-fed cattle, finding them less acceptable because of a lower dressing percentage, higher cooler shrinkage, and lower quality grade, (data cited by Colorado). Researchers from Kansas State University and elsewhere have reported that grass fattened beef is variable in such quality factors as flavor and lean color. A recent study from Colorado (1980) reported that carcasses of cattle fed all-forage diets had increased cutability, but also had increased cooler shrinkage and lowered dressing percentage. Steaks from cattle fed all-forage diets had limited retail acceptability and low scores for palatability. Short term use of high grain finishing diets has the advantages of improving qualitative characteristics, lean color, dressing percentage, and retail acceptability compared to carcasses finished only on forage.

If a consumer acceptable beef carcass can be produced with maximal forage inputs and minimal grain input and still maintain a producer profit potential, then beef cattle competitiveness with human demands for cereal grains will be reduced.

The objectives of this research were to:

1) measure and compare the rate, composition, and efficiency of steer gains using production systems varying in the amount of total body weight gain produced on pastures, corn silage, or corn grain;
2) evaluate steer gains when grazing summer pastures containing only fescue grass or a combination of fescue grass: red clover legume;
3) further evaluate steer gains from objective 2 when finished with corn grain, fed on pasture, and slaughtered at two differing weights;
4) evaluate steer rate and efficiency of gain and days on feed on a high corn finishing diet after animals grazed summer fescue, fescue: birdsfoot trefoil, or fescue: red clover pastures.

PROCEDURES

Four production systems for growing and finishing beef steers from weaning to slaughter were selected to provide variation in both forage and grain inputs, final slaughter weight, and days on feed. There were a total of thirteen different treatments within the four production systems.

The four production systems were each evaluated for three separate years. Steers fed a two phase corn silage growing diet followed by a corn grain finishing diet were compared to steers grazing only fescue grass or steers grazing fescue grass: red clover legume combination growing diets followed by a corn grain finishing diet fed on pasture.

Rate and efficiency of gains were also measured for steers in the feedlot on a corn grain finishing diet following a growth trial where steers had grazed summer fescue grass, fescue grass: birdsfoot trefoil legume combination, or fescue grass: red clover legume combination pastures.

Hereford x Angus crossbred steers selected for the differing production systems were purchased in the fall of each year (approximately mid-October) as weanling animals weighing approximately 450 pounds. Upon arrival at the University Farm, steers were wormed, vaccinated, poured for grubs and lice, implanted with a growth promoter, eartagged, branded and analyzed if possible for body fat and lean using the ^{40}K Whole Body Counter. Steers were assigned to the different systems by weight and body composition so as to minimize initial animal to animal variation for the different systems. Steers were placed directly in the feedlot for System 1, while steers for Systems 2 through 4 were backgrounded on stockpiled pasture and hay from October until approximately April 15. All animals were weighed at 28 day intervals for the entire trial.

SYSTEM 1

Treatment 1

Each year ten steers were placed in the feedlot and fed a corn silage based diet (Table 1) until an average slaughter weight of 800 pounds was achieved.

Treatment 2

Each year ten steers were placed in the feedlot and fed a corn silage based diet until the animals reached 800 pounds. After this time steers were fed a corn grain finishing diet (Table 1) until an average slaughter weight of 950 pounds was achieved.

Treatment 3

This treatment is similar to Treatment 2, except that steers were slaughtered when body weight averaged 1050 pounds.

SYSTEM 2

Treatments 4 and 6

Approximately April 15 of each year, after winter feeding on stockpiled pasture and hay, 18 steers were weighed and placed in two five acre fescue pastures (nine steers/pasture).

After gaining approximately 100 pounds, steers were adapted to *ad libitum* ground corn feeding which was supplied in self feeders. When the steers averaged 950 pounds, nine were removed and slaughtered (Treatment 4). The second nine steers were slaughtered when body weight averaged 1050 pounds (Treatment 6).

Treatments 5 and 7

The number of steers and size of pastures were similar to Treatments 4 and 6 except that animals grazed two five acre fescue: red clover combination pastures instead of fescue grass pastures only. Steers were fed ground corn in self feeders at the same time as for Treatments 4 and 6. Nine steers were slaughtered at 950 pounds (Treatment 5) and nine steers were slaughtered at 1050 pounds (Treatment 7).

SYSTEM 3

This system is described in the article by Matches *et al.* elsewhere in this publication.

SYSTEM 4

One-half of the steers from System 3 (twenty-seven animals) were placed in the feedlot and fed a corn grain finishing diet (Table 1) until an average slaughter weight of 1050 pounds was achieved. Treatments were: Treatment 11 (animals that had previously grazed fescue); Treatment 12 (animals that had previously grazed fescue: red clover); and Treatment 13 (animals that had previously grazed fescue: birdsfoot trefoil).

RESULTS AND DISCUSSION

System 1; Treatments 1, 2, and 3

The average feedlot performance for steers assigned to these three treatments is presented in Table 2. Steers fed a silage only diet (Treatment 1) were fed for 205 days, gained 1.71 lb/day, and had a feed efficiency of 7.25. The average slaughter weights of these animals was 839 pounds.

Steers from Treatment 2 gained 1.54 lb/day on corn silage growing diet (201 days), and then required another sixty-nine days on the finishing diet to obtain a 965 lb slaughter weight (2.47 lb/day gain). Steer feed efficiency was 8.08 when fed a corn silage diet and was 8.15 when fed the finishing corn grain diet.

Steers from Treatment 3 gained 1.65 lb/day on the corn silage growing diet (201 days) and when switched to the corn grain finishing diet, required an additional 102 days to reach a 1072 pound slaughter weight. Daily gain and feed efficiency were 2.42 lb and 7.89, respectively.

Daily gains for steers fed the finishing diet were greater than for the previous corn silage feeding phase, as would be expected, but feed efficiency values were approximately the same for steers fed either 69 or 102 days. It might be expected that the longer feeding time for Treatment 3 cattle would have decreased the efficiency of gain, but this was not true for this experiment. Steers slaughtered at 965 pounds were consuming 2.09% of their body weight, whereas steers fed for an additional 33 days were consuming 1.78% of their body weight when averaged over the 102 day feeding. It should be expected however, that a marked depression in gain efficiency would occur with overly fat animals. This is because much of the energy in the diet goes for meeting the animal's maintenance needs.

System 2; Treatments 4, 5, 6, and 7

Steers grazing fescue: red clover pastures gained 28% faster than steers grazing fescue only pastures (1.06 vs. .83 lb, respectively; three year average), Table 3. The initiation of pasture grazing was approximately April 15 of each year and continued for 85 days after which time all steers were offered corn ad libitum in self feeders.

It did not appear that steers grazing fescue only pastures exhibited any compensatory gains when offered corn in self feeders. Steers slaughtered at the lighter weight (4) gained 2.38 lb/day on fescue pasture and 2.41 lb/day on fescue: red clover pastures (5). Gains were identical (2.38 lb) for steers slaughtered at the heavier weights (6 and 7) comparing fescue vs. fescue: red clover pastures. Daily gains for all steers fed corn were approximately the same regardless of days on pasture or differing slaughter weights. Average daily consumption of corn grain was similar between the different treatments.

System 4; Treatments 11, 12, and 13

Steers that had grazed summer fescue grass pasture entered the feedlot at lighter starting weights than steers that had grazed fescue: red clover or fescue: birdsfoot trefoil pastures, Table 4. These steers had gained approximately 38 fewer pounds than steers grazing fescue: legume pastures. Possibly because of this slower performance on fescue only pastures, these steers exhibited compensatory feedlot growth when fed the corn finishing diet. Daily gains for these steers were 8.8% faster than steers grazing fescue: red clover and were 3.6% faster than for steers grazing fescue: birdsfoot trefoil pastures. Feed efficiency also favored steers that had grazed fescue only pastures (6.61) compared to steers grazing fescue: red clover (7.18) or fescue: birdsfoot trefoil, (6.87).

Days on feed:

Only one group of cattle (Treatment 1) was slaughtered at 850 pounds and this required an average of 205 days. Comparing the different systems where an endpoint slaughter weight of 950 pounds was selected found that steers fed corn silage-corn grain required 270 days to reach this weight. Steers from Treatments 4 and 5 required an average 395 days to reach a slaughter weight of approximately 1036 pounds, (153 days on winter backgrounding, 88 days on pasture, and 154 days on pasture + corn).

Comparing the different systems where an endpoint slaughter weight of 1050 pounds was selected found that steers fed corn silage-corn grain required 303 days to reach a slaughter weight of 1072 pounds, while steers from Treatments 6 and 7 required 416 days to reach a slaughter weight of 1082 pounds, (153 days on winter backgrounding, 88 days on pasture, and 175 days on pasture + corn).

From the consumer's standpoint, the marketing of all-forage fed beef carcasses should be considered. Reduced shelf life, a darker, less attractive lean color, and decreased palatability are areas of concern. Varied length of grain feeding for finishing beef cattle has advantages of increasing carcass weight, muscle mass growth rate, and palatability (Colorado data).

The final conclusions from these different systems will depend upon consumer acceptability of the type of carcass produced. From the producer's standpoint, management decisions based on land prices, interest rates, feed costs and other non-feed costs will dictate which systems have opportunities for efficiency and profit potential.

Table 1. Ration Composition for Steers Fed in Feedlot (Treatments 1, 2, 3, 11, 12, 13)

Item	Treatments: Growing Diet (Treatments 1,2,3)	Finishing Diet (Treatments 1,2,3,11,12,13)
	%	%
Corn silage	87.57	25.89
Corn grain	7.96	71.19
Soybean meal	1.56	1.01
Urea	1.29	.83
Limestone	.54	.35
Dicalcium phosphate	.20	.13
T.M. salt	.38	.25
Vit. A and D	.20	.14
Rumensin, mg/day	250	250

[a]Dry basis.

Table 2. Growing and Finishing Feedlot Performance of Steers for Treatments 1, 2, and 3.[a]

System 1

Year	Treatment 1	Treatment 2		Treatment 3	
1977	Silage	Silage	Corn	Silage	Corn
No. Animals	9	9		9	
Initial wt., lb	456	464		444	
Days on feed	210	210	69	210	95
Daily gain, lb	1.78	1.56	2.16	1.90	2.25
Final wt., lb	830	--	941	--	1057
DM/ unit gain	6.41	7.52	7.87	7.37	7.45
1978	Silage	Silage	Corn	Silage	Corn
No. Animals	10	10		10	
Initial wt., lb	494	488		499	
Days on feed	196	196	51	196	107
Daily gain, lb	1.67	1.52	2.49	1.54	2.41
Final wt., lb	832	--	913	--	1058
DM/unit gain	7.63	8.38	6.80	8.27	8.36
1979	Silage	Silage	Corn	Silage	Corn
No. Animals	10	10		10	
Initial wt., lb	514	504		534	
Days on feed	209	196	86	196	105
Daily gain, lb	1.64	1.54	2.75	1.51	2.60
Final wt., lb	856	--	1041	--	1103
DM/unit gain	7.93	8.34	7.29	8.50	7.87
Three Year Average	Silage	Silage	Corn	Silage	Corn
No. Animals	29	29		28	
Initial wt., lb	488	485		492	
Days on feed	205	201	69	201	102
Daily gain, lb	1.71	1.54	2.47	1.65	2.42
Final wt., lb	839	--	965	--	1072
DM/unit gain	7.25	8.08	8.15	8.04	7.89

[a]Treatment 1 = silage only, slaughter at 850 lb.
Treatment 2 = silage followed by corn finishing diet, slaughter at 950 lb.
Treatment 3 = silage followed by corn finishing diet, slaughter at 1050 lb.

Table 3. Pasture and Pasture + Corn Performance of Steers Fed to Two Slaughter Weights for System 2

Year	Treatments			
	System 2 (Fescue)		System 2 (Fescue: Red Clover)	
1977	4[a]	6[b]	5[a]	7[b]
No. Animals	10	9	8	8
Initial wt., lb	586	582	574	592
Final wt., lb	1004	1114	1054	1121
Days on:				
pasture	84	84	84	84
pasture + corn	200	225	200	225
Daily gain, lb:				
pasture	1.19	1.27	1.52	1.18
pasture + corn	1.59	1.89	1.76	1.91
Daily corn consumed, lb	11.12	11.10	11.54	13.29
	System 2 (Fescue)		System 2 (Fescue: Red Clover)	
1978	4[a]	6[b]	5[a]	7[b]
No. Animals	9	9	9	9
Initial wt., lb	652	658	638	653
Final wt., lb	1075	1064	1067	1113
Days on:				
pasture	84	84	84	84
pasture + corn	132	146	132	146
Daily gain, lb:				
pasture	.77	.54	1.06	.83
pasture + corn	2.71	2.47	2.58	2.67
Daily corn consumed, lb	16.15	17.12	15.99	16.36
	System 2 (Fescue)		System 2 (Fescue: Red Clover)	
1979	4[a]	6[b]	5[a]	7[b]
No. Animals	9	9	9	9
Initial wt., lb	572	563	580	565
Final wt., lb	986	1046	1026	1033
Days on:				
pasture	88	88	88	88
pasture + corn	129	154	129	154
Daily gain, lb:				
pasture	.56	.63	.86	.88
pasture + corn	2.84	2.78	2.88	2.55
Daily corn consumed, lb	16.17	16.25	16.51	16.43
	System 2 (Fescue)		System 2 (Fescue: Red Clover)	
Three Year Average	4[a]	6[b]	5[a]	7[b]
No. Animals	28	26	27	26
Initial wt., lb	603	601	597	603
Final wt., lb	1022	1075	1049	1089
Days on:				
pasture	85	85	85	85
pasture + corn	154	175	154	175
Daily gain, lb:				
pasture	.84	.81	1.15	.96
pasture + corn	2.38	2.38	2.41	2.38
Daily corn consumed, lb	14.48	14.82	14.68	15.36

[a] 4 and 6 slaughtered at 950 pounds.

[b] 5 and 7 slaughtered at 1050 pounds.

Table 4. System 4 Feedlot Performance of Steers on Finishing Diet.[a]

	Previous Grass Treatment		
Year Treatment:	11	12	13
1977	Fescue	Fescue: Red Clover	Fescue: Birdsfoot Trefoil
No. Animals	8	9	9
Initial wt., lb	671	738	692
Days on feed	127	127	127
Daily gain, lb	3.26	2.87	3.09
DM/unit gain	6.10	6.93	6.44
1978	Fescue	Fescue: Red Clover	Fescue: Birdsfoot Trefoil
No. Animals	9	9	9
Initial wt., lb	650	684	694
Days on feed	138	138	138
Daily gain, lb	3.13	3.00	3.01
DM/unit gain	7.93	8.28	8.25
1979	Fescue	Fescue: Red Clover	Fescue: Birdsfoot Trefoil
No. Animals	9	9	9
Initial wt., lb	682	693	732
Days on feed	104	104	104
Daily gain, lb	4.06	3.73	3.98
DM/unit gain	5.81	6.32	5.92
Three Year Average	Fescue	Fescue: Red Clover	Fescue: Birdsfoot Trefoil
No. Animals	26	27	27
Initial wt., lb[b]	668	705	706
Days on feed	123	123	123
Daily gain, lb	3.48	3.20	3.36
DM/unit gain	6.61	7.18	6.87

[a]Performance of steers grazing the three pasture types (System 3) is described in the article by Matches *et al.* elsewhere in this publication.

[b]Three year average final weight: 11 = 1090; 12 = 1094; 13 = 1114 lb.

COMPARISON OF PASTURE AND FEEDLOT PRODUCTIONS SYSTEMS ON BEEF CARCASS CHARACTERISTICS AND PALATABILITY OF STEAKS

J.D. Thomas, A.G. Matches, J.A. Paterson, R.E. Morrow, D. Sicht, W.C. Stringer and H.B. Hedrick

SUMMARY

Carcasses from animals fed on 13 differing feeding regimens were evaluated for carcass characteristics and palatability of loin steaks. Carcasses from grass-fed (Treatments 8, 9 and 10) and silage-fed (Treatment 1) treatments had the lowest carcass weights, lowest dressing percentages and the lowest quality and yield grades. Steaks from the grass-fed animals were scored the lowest by the taste panel for flavor, tenderness and overall acceptability. However, the taste panel scored steaks from the silage-fed animals similar to steaks from long-fed animals. Carcasses from animals fed grain on grass had the most external fat and the highest yield grade. Steaks from these carcasses were rated lower in flavor by the taste panel than steaks from animals which were fed grain while in drylot. Carcasses from all treatments except 8, 9 and 10 (grass-fed) produced steaks and roast which were rated as being acceptable by the taste panel.

INTRODUCTION

Due to an ever increasing world population, competition between animals and man for cereal grains is increasing. Because of this, researchers are investigating developing feeding programs that maximize the use of forage in the animal's diet. Forage is useful because the ruminant animal can convert it into meat. Also, forage can be grown on land that is not or could not be used for cereal grain production.

Previous research has shown that animals finished strictly on forage diets are not acceptable to commercial meat processors and their meat has low consumer acceptability. Animals from strictly forage diets have low dressing percentages, low quality grade, and low tenderness and flavor desirability.

Undoubtedly, grain is necessary in the animal's diet to produce acceptable meat. The problem being investigated is the proportion of forage and grain in the diet needed to produce acceptable meat and maintain a profit potential for the producer.

The objectives of the present study were to:

1) measure the composition and quality of carcasses from animals fed varying amounts of forage and grain;
2) assess by trained taste panelists the flavor, tenderness and overall acceptability of steaks from these carcasses.

PROCEDURE

Feeding and Management Treatments Feeding and management treatments are outlined in Table 1. See report in present publication entitled "Comparison of Pasture *Versus* Feedlot Production Systems for Finishing Beef Cattle" by John A. Paterson *et al*. for more detailed description of the thirteen feeding and management treatments. The thirteen treatments were categorized into four systems: System 1 - silage, System 2 - grain on pasture, System 3 - pasture, and System 4 - pasture followed by grain in drylot.

Carcass Characteristics Animals were slaughtered at the University of Missouri abattoir or local packing company. After a 48 hour chill, carcasses were assigned quality and yield grades according to USDA Beef Carcass Grading Standards.

Taste Panel Evaluation One inch thick steaks from the anterior portion of the short loin were oven broiled at an oven temperature of 350° F. to an internal temperature of 158° F. Samples of cooked steak were presented to a six member taste panel, who evaluated the samples for tenderness, flavor, and overall acceptability. An eight point scale was used to score the samples, (8 = extremely desirable to 1 = extremely undesirable).

RESULTS

Carcass Quality and Composition The live weights of the animals at time of slaughter followed a predictable pattern (Table 2). The shorter fed animals (Treatment 1) and the grass-fed groups (Treatments 8, 9 and 10) had the lowest slaughter weights. All other feeding treatments produced animals with an average slaughter weight over 1,000 pounds.

The fescue-fed animals (Treatment 8) had lower live weights than animals fed fescue overseeded with red clover or birdsfoot trefoil (Treatments 9 and 10). Treatment 11, the corresponding long fed group to Treatment 8, also ranked below the long fed groups Treatments 12 and 13 corresponding to Treatments 9 and 10. This indicates that overseeding with red clover or birdsfoot trefoil resulted in increased gains which carried through the feedlot finishing phase. System contrasts for live weight are presented in Table 5. All systems were significantly different.

Carcass weight data are presented in Table 2. The treatments that produced the heaviest live weight also produced the heaviest carcass weights. All treatments, with the exception of 1, 8, 9 and 10 produced acceptable weight carcasses. System analysis (Table 5) for carcass weight followed the same pattern as the live weight system analysis. Although there are statistical differences, Systems 1, 2 and 4 produced carcasses of acceptable weights.

Dressing percent was highly dependant on feeding regimen (Table 2). The lighter weight animals of Treatments 1 (silage-fed), 8, 9 and 10 (pasture-fed) had the lowest dressing percentage. Treatments 4 and 5 were generally intermediate while the other long fed treatments had higher dressing percentages. Comparison of systems for dressing percentage is presented in Table 5. The only significant difference was the low dressing percentage of System 3, pasture-fed animals.

TABLE 1

NUTRITIONAL TREATMENTS[1]

Production system number	Treatment number	Wintering phase	Grazing phase	Finishing phase
I	1	Corn silage		Corn silage
I	2	Corn silage		Grain in drylot
I	3	Corn silage		Grain in drylot
II	4	Hay, pasture	Fescue	Grain on pasture
II	5	Hay, pasture	Fescue & Red clover	Grain on pasture
II	6	Hay, pasture	Fescue	Grain on pasture
II	7	Hay, pasture	Fescue & Red clover	Grain on pasture
III	8	Hay, pasture	Fescue	
III	9	Hay, pasture	Fescue & Red clover	
III	10	Hay, pasture	Fescue & Trefoil	
IV	11	Hay, pasture	Fescue	Grain in drylot
IV	12	Hay, pasture	Fescue & Red clover	Grain in drylot
IV	13	Hay, pasture	Fescue & Trefoil	Grain in drylot

[1]See report in present publication entitled "Comparison of Pasture Versus Feedlot Production Systems For Finishing Beef Cattle" by John A. Paterson, et al.

TABLE 2

MEAN[1] LIVE WEIGHT, CARCASS WEIGHT AND DRESSING PERCENT OF STEERS AS INFLUENCED BY NUTRITIONAL TREATMENT

Treatment Number[2]	Live Weight (Pound)	Carcass Weight (Pound)	Dressing Percent
1	839.47^{f}	459.03^{d}	54.67^{f}
2	968.90^{e}	590.91^{c}	60.98^{ab}
3	1074.19^{bc}	663.68^{a}	61.82^{a}
4	1021.67^{d}	597.07^{bc}	58.50^{e}
5	1049.19^{cd}	615.07^{b}	58.62^{e}
6	1074.44^{bc}	645.82^{a}	60.09^{bc}
7	1089.04^{ab}	655.53^{a}	60.21^{bc}
8	651.93^{h}	344.44^{f}	52.82^{g}
9	693.63^{g}	369.22^{e}	53.19^{g}
10	706.00^{g}	369.74^{e}	52.37^{g}
11	1090.06^{ab}	644.55^{a}	59.06^{de}
12	1093.93^{ab}	652.22^{a}	59.63^{cd}
13	1113.78^{a}	661.85^{a}	59.42^{cde}

[1]Where superscript letters differ within a column, means differ significantly ($P < .05$) from each other.

[2]See Table 1 for a description of nutritional treatments.

TABLE 5

MEAN[1] CHARACTERISTICS OF STEERS AS INFLUENCED BY PRODUCTION SYSTEM[2]

Item	Production System[2] 1	2	3	4
Live Wt. lb.	959.01[a]	1056.97[b]	683.85[c]	1099.44[d]
Carcas Wt.lb.	569.85[a]	626.90[b]	361.14[c]	652.94[d]
Dressing Percent	59.12[a]	59.31[a]	52.79[b]	59.37[a]
Quality Grade	9.31[a]	9.66[b]	5.00[c]	9.68[b]
Fat Thickness, (in.)	.41[a]	.53[b]	.08[c]	.49[d]
Rib Eye Area, (sq. in.)	10.36[a]	10.45[a]	7.83[b]	10.91[c]
Yield Grade	2.83[a]	3.42[b]	1.77[c]	3.21[d]
Flavor	6.44[a]	6.21[b]	5.07[c]	6.48[a]
Tenderness	6.33[a]	5.78[b]	4.91[c]	6.18[a]
Overall Acceptability	6.42[a]	6.04[b]	5.06[c]	6.34[a]

[1]Where superscript letters differ within the same line, means differ significantly ($P<.05$) from each other.

[2]See Table 1 for a description of production systems.

USDA Quality grades are presented in Table 3. With the exception of Treatments 1, 8, 9 and 10 all treatments produced USDA High Good to Low Choice carcasses. Treatment 1 (silage-fed) carcasses were graded as USDA Low Good while Treatments 8, 9 and 10 (pasture-fed) were graded as USDA Low to Average Standard. Treatments 1, 8, 9 and 10 did not provide the energy necessary to grow and fatten animals to the Choice grade. Comparison of Systems (Table 5) indicate that Systems 1, 2 and 4 produced USDA high Good to low Choice carcasses while System 3 produced average Standard carcasses. The primary reason System 1 was significantly lower than Systems 2 and 4 was due to the lower USDA Quality grade (Good-) of Treatment 1.

The animals on the high energy grain diets had greater external fat covering than the lower energy level diets (Table 3). In Treatments 1 through 10 the amount of external fat cover was directly related to the energy level of the diet. However, Treatment 11 did not follow this pattern. Carcasses from Treatment 11 had less fat than those from Treatment 12 and 13. Correspondingly, carcasses from Treatment 8 had less fat cover than those from Treatments 9 and 10 indicating Treatment 8 animals were on a lower nutritional plane than Treatments 9 or 10. Animals from Treatment 8 when placed in dry lot and fed grain, did not deposit as much fat as did animals from previous Treatments 9 and 10. However, ribeye area (Table 3) for Treatment 11, within the 3 years and in the combined average, was not significantly different from Treatments 12 and 13. Still, in the combined average carcasses from Treatment 8 had significantly smaller ribeye areas than carcasses from Treatments 9 or 10. Treatment 11 animals had smaller ribeyes at the end of the pasture phase, but during the finishing phase in dry lot these animals underwent a more rapid rate of muscle growth than did animals on Treatments 12 and 13. In other words, during dry lot feeding, Treatment 11 animals produced more muscle and less fat than animals on Treatments 12 and 13. This growth pattern can be attributed to compensatory growth of muscle by Treatment 11 animals.

System analysis (Table 5) indicates that System 3 had the smallest ribeye areas. However, System 4 had significantly larger ribeye areas than all other systems.

Carcasses from Treatments 6 and 7, which had more fat thickness, also had higher yield grades (Table 3). Although carcass weights were not significantly different from those of Treatments 3, 11, 12 and 13, slightly smaller ribeyes combined with greater fat thickness resulted in higher yield grades. Fat thickness of Treatment 3 carcasses was not significantly different from that of Treatments 6 and 7, but the ribeye area was larger for Treatment 3 carcasses. This resulted in the yield grade for Treatment 3 carcasses being significantly less than that of Treatment 6 and 7 carcasses. Carcasses from Treatments 8, 9 and 10 had the lowest yield grades. This was due mainly to the small amount of external fat cover. Less fat thickness for Treatment 11 carcasses also resulted in a significantly lower yield grade than for Treatment 12 and 13 carcasses. Yield grades were highest for System 2 and lowest for System 3 (Table 5).

Treatments 8, 9 and 10 produced the highest cutability carcasses. However, their low USDA Quality grade and small muscle size would make these carcasses undesirable for production of steaks and roasts. Also, their low dressing percentage would increase their per volume slaughtering and processing costs as compared to the treatments with higher dressing percentages.

TABLE 3

MEAN[1] CARCASS GRADE, FAT THICKNESS AND RIB EYE AREA OF STEERS AS INFLUENCED BY NUTRITIONAL TREATMENT

Treatment Number[2]	Quality Grade	Fat thickness (inch)	Rib Eye Area (sq. inch)	Yield Grade
1	7.60[e]	.22[f]	9.18[e]	2.42[e]
2	9.82[bc]	.45[de]	10.79[abcd]	2.79[a]
3	10.49[a]	.56[ab]	11.22[a]	3.40[b]
4	9.19[d]	.49[cde]	10.36[d]	3.20[bc]
5	9.41[cd]	.49[cde]	10.38[d]	3.23[bc]
6	9.87[abc]	.57[ab]	10.45[cd]	3.64[a]
7	10.24[ab]	.59[a]	10.65[bcd]	3.64[a]
8	4.56[g]	.07[g]	7.46[g]	1.78[f]
9	5.30[f]	.08[g]	8.08[f]	1.73[f]
10	5.14[fg]	.09[g]	7.94[f]	1.80[g]
11	9.87[abc]	.43[e]	10.92[abc]	3.02[c]
12	9.67[bcd]	.51[bcd]	10.82[abcd]	3.28[b]
13	9.52[cd]	.52[bc]	11.01[ab]	3.31[b]

[1]Where superscript letters differ within a column, means differ significantly ($P<.05$) from each other.

[2]See Table 1 for a description of nutritional treatments.

All other treatments produced carcasses which could be easily utilized for fabrication into steaks and roasts.

Steaks from animals on Treatments 8, 9 and 10 (pasture) were rated less desirable for flavor, tenderness and overall acceptability than steaks from animals on all other treatments (Table 4). System analysis (Table 5) shows that steaks from Systems 1 and 4 were not significantly different and were ranked higher than steaks from Systems 2 and 3. In System 1 all treatments were statistically the same. Silage feeding alone (Treatment 1) had no detrimental effect on flavor, tenderness or overall acceptability as opposed to silage feeding followed by a high energy corn diet. This occurred even though carcasses from Treatment 1 had a significantly lower USDA Quality grade and marbling score than those from Treatments 2 and 3.

System 2 was significantly higher than System 3 but lower than Systems 1 and 4 for flavor. Still, System 2 had the same marbling score and a greater amount of external fat cover than Systems 1 and 4. Since System 2 animals were fed grain while still grazing on pasture it is possible that they still retained some of the flavor that is typical of animals fed on grass.

Treatment 8 was given the lowest tenderness (Table 4). This was the only treatment rated as being slightly tough.

Systems 1 and 4 rated significantly more tender than either System 2 or 3 (Table 2). System 3 was significantly lower than all other systems.

Acceptability scores for treatments and systems are presented in Tables 4 and 2. As expected, Treatments 8, 9 and 10 (System 3) were given the lowest scores. Also, Treatments 4, 5, 6 and 7 (System 2) were given the next lowest scores. Treatment 1, 2 and 3 (System 1) and 11, 12 and 13 (System 4) showed little difference.

TABLE 4

MEAN[1] TASTE PANEL SCORES[2] OF LOIN STEAKS FROM STEERS AS INFLUENCED BY NUTRITIONAL TREATMENT

Nutritional Treatment[3]	Flavor	Tenderness	Overall Acceptability
1	6.45[abc]	6.33[a]	6.41[ab]
2	6.51[ab]	6.48[a]	6.48[a]
3	6.33[abcd]	6.15[abc]	6.31[abcd]
4	6.14[d]	5.82[bc]	6.02[cd]
5	6.17[cd]	5.85[bc]	6.00[d]
6	6.20[bcd]	5.76[c]	6.05[cd]
7	6.35[abcd]	5.69[c]	6.11[bcd]
8	5.06[e]	4.54[e]	4.98[e]
9	5.14[e]	5.13[d]	5.14[e]
10	4.99[e]	5.06[d]	5.05[e]
11	6.50[ab]	6.22[ab]	6.37[abc]
12	6.36[abcd]	6.10[abc]	6.23[abcd]
13	6.57[a]	6.23[ab]	6.44[ab]

[1]Where superscript letters differ within a column, means differ significantly ($P < .05$) from each other.

[2]Range of scores: 1, extremely unacceptable to 8, extremely acceptable.

[3]See Table 1 for description of nutritional treatments.

TOMATO BREEDING AND IMPROVED MANAGEMENT PRACTICES

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Abstract: The first research year (1979) for tomato at the Southwest Center established Missouri's first record of 50T/A. total yield. Under drip irrigation, early transplanting (May 3) increased total yield about 4T/A. over June 20 transplanting. Irrigation had little effect on yield of late-planted determinate lines because of timely rainfall. Varietal yields were striking, varying from 21T/A for Stone to over 50T/A for several hybrids.

Tomato research at the Southwest Center in 1979 established two important "firsts" -- the first year for tomato research at the Center and the first record of test yields reaching 50 tons per acre.

The 1979 planting included 36 varieties, hybrids and breeding lines transplanted to the field on May 3 and June 20 and "trickle" irrigated. Early transplanting (May 3) increased total yield on the average about 4 tons per acre, considering all varieties under irrigation (Table 1). Nine unirrigated determinate lines yielded slightly better with the June 20 transplanting, likely because their "flush of bloom" came during a period of more favorable temperatures and rainfall this season.

Table 1. Effect of transplanting date on tomato yield. 1979.

Transplanting Date	Irrigated	Number of Lines	Mean total Yield T/A.
May 3	Yes	36*	41.4
	No	9	33.9
June 20	Yes	36*	37.2
	No	9	38.4

* Varieties under irrigation included 27 indeterminates and 9 determinates.

Since the rainfall amounts and distribution were both good in 1979, the response to drip irrigation was less than normal, especially with determinate lines. Indeterminate varieties responded better than the determinate ones, as fruiting occurred over a longer period of time with greater chance for moisture stress.

Table 2. Effect of drip irrigation on yield of 6 determinate tomato lines. 1979.

	Drip Irrigated		Unirrigated	
Line	May 3	June 20	May 3	June 20
Mo. P3004	38.8 T/A	44.3 T/A	18.6 T/A	28.9 T/A
Mo. P2146	36.6	43.4	25.6	39.7
Red Pak	24.9	35.5	35.3	40.0
Stone	21.0	34.1	40.8	39.5
Sun-Up	42.2	51.1	34.6	43.3
Mo. P2151	35.7	43.9	44.1	45.8
Mean	33.20	42.05	33.16	39.53

Varietal responses were striking (Table 3). For the May 3 transplanting, total yields varied from 21 T/A. for Stone to over 50 T/A. for Avalanche, Mo. 33-St-3 VFN and six other commercially available hybrids. Total yield for SHOW-ME,a crack-resistant, firm-fleshed hybrid released by the Missouri Agricultural Experiment Station in 1978, was 45T/A. Marketable yields of all varieties would be lower because of fruit defects such as cracking, which varied widely among varieties.

Table 3. Comparison of 33 tomato lines for yield and fruit size. University of Mo., Southwest Center, Mt. Vernon. 1979.

Line	Determinate (D) Indeterminate (I)	Fruit size Lb/Fruit	Total Yield T/A May 3 planting	Total Yield T/A June 20 planting
Big Boy	I	0.57	51.2	45.6
Better Boy	I	0.51	48.4	35.9
Sunray	I	0.46	36.3	30.1
Pink Delight	I	0.40	28.3	34.5
Mo Cross Supreme	I	0.37	50.8	34.4
Pink Gourmet	I	0.84	45.6	34.4
Mo. 36-St-30	I	0.68	44.2	38.4
Mo. 33-St-3	I	0.51	53.7	48.6
Big Set	D	0.48	42.6	38.3
He-Man	I	0.52	44.5	30.6
Early Cascade	I	0.19	45.1	34.3
Flor America	I	0.59	53.8	45.2
Big Girl	I	0.58	58.3	51.4
Castlex 1025	D	0.31	27.5	31.5
Red Pak	D	0.50	24.9	35.5
Jet Star	I	0.41	43.0	32.5
Castle Hy 105	I	0.55	51.1	33.4
Red Heart	I	0.55	48.6	42.1
SHOW-ME	I	0.50	45.2	28.8
SURPRISE	I	0.34	42.7	23.6
Pink Savor (salad)	I	0.06	42.2	30.7
Mo 38-Y-33	I	0.45	30.0	36.1
Puffy	I	0.36	47.3	43.9
Sun Up	D	0.35	42.2	51.1
Avalanche	I	0.41	52.0	37.5
Traveler 76	I	0.40	41.1	36.8
Mo. P3004	D	0.30	38.8	44.3
Mo. P2151	D	0.26	35.7	43.9
Mo. P2146	D	0.24	36.6	43.4
Rutgers	I	0.34	37.1	22.8
Marglobe	I	0.41	34.0	34.5
Stone	D	0.27	21.0	34.1
Supersteak Hy	I	1.08	50.6	40.3

GRAPE VARIETY PERFORMANCE TESTING

Southwest Missouri Center, Mt. Vernon

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Abstract: In establishing a grape vineyard, first year training goals are: 1) set plants in early spring; 2) install trellis system; 3) train plants to a single stem to the top wire. The majority of plants of 24 varieties (35 varieties under test) reached the top wire by the end of the first growing season.

The purpose of this research is to study and evaluate growth and production (yield and quality) of seedless, table and wine grapes grown on Eldon cherty silt loam.

Thirty-five varieties of grapes were planted on April 19, 1979. Special cultural systems for this study include:

1. automatic trickle irrigation
2. plant/row spacings: 8 x 10 feet
3. 6 ft. Single Cordon trellis system
4. grapes planted on berms; berms mulched with sawdust
5. permanent row middles, bluegrass sod
6. north-south row orientation

It is considered desirable to install the trellis system for grapes the year of planting and to train the grape plant to a single shoot, supported with a stake, to the top wire. First year growth of the 35 varieties is summarized in Table 1.

Table 1. One year growth of some 35 grape varieties.

	Categories of 1st year shoot growth				
	No. of Plants	To the Top Wire	More than Three Feet	Less than Three Feet	Dead
General Use Grapes					
Catawba	3	2	1		
Concord	3		3		
Niagara	3	3			
Seedless Grapes					
Canadice	9		5	4	
Glendora	3	2	1		
Himrod	9	8	1		
Lakemont	9	6	3		
NY 47-616	12	7	2	3	
Pinky (unknown)	9	4	5		
Romulus	3	3			
Suffolk Red	12	4	5	3	
Venus	9	4	5		
Table Grapes					
Alden	3		2	1	
Alwood	3	2		1	
Monticello	3			3	
Steubin	3	3			
Vinered	3	3			
Yates	3		3		
Wine Grapes					
Blue Eye	3	2	1		
Cayuga White	9	6	1	2	
Chambourcin	9	9			
Chancellor	9	9			
Norton (Cynthiana)	3			3	
De Chaunac	9	8	1		
GW 5	9	4	5		
GW 7	9	8	1		
J.S. 23-416	9	7	1	1	
Missouri Riesling	3		2	1	
Seyval Blanc	9	9			
S-V 5-274	9	9	1		1
S-V 23-512	9	6	3		
Vidal Blanc	9	9			
Vignoles	9	5	1	3	
Villard Blanc	9	8	1		
Villard Noir	9	9			

BLUEBERRY PERFORMANCE EVALUATION

Southwest Missouri Center, Mt. Vernon

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Abstract: After one full growing season, highbush blueberry plants generally showed good vigor and low mortality. Soil pH was lowered to some extent with a dilution of sulfuric acid, although the effects were not persistent for the whole season. 'Bluecrop' and 'Collins' were rated as the best first year cultivars.

An experimental blueberry planting was established on April 19, 1979 at the Southwest Missouri Center comprising 4 varieties (Bluecrop, Collins, Coville, Bluetta) with 6 replications of 4 plants per replication. In addition, 4 plants each of 'Blueray' and 'Earliblue' were planted. Superimposed over varieties were 2 irrigation tests designed to study plant responses to different water distribution patterns.

Prior to planting, 20 gallons of 7.5% sulfuric acid was incorporated into each 400 sq. ft. of plant row. Soil samples were taken prior to planting and at intervals thereafter. Sulfuric acid, in this case, appears to lower soil pH a significant extent early in the season (Table 1), although not as dramatically as was anticipated; however, the effect had worn off at the end of the growing season.

Table 1. Effect of Sulfuric Acid on Soil pH (1979) - Southwest Center.

Date	pH
April 18	6.5
June 8	5.3
November 24	6.3

Although some plants showed symptoms of stress such as yellowish leaves and early development of red leaf color, no obvious symptoms of iron chlorosis were manifested. Additional sulfur in the form of microfine wettable sulfur was applied in October of 1979 to re-establish the desired pH.

In early spring of 1980 all plants were rated on vigor based on height, width, leaf color and overall appearance (Table 2). "Bluecrop" and 'Collins' performed best with no mortality while 'Bluetta' incurred some winter damage and was not as vigorous. "Coville', unquestionably, did not perform well and suffered significant winter kill.

Table 2. Blueberry Plant Vigor (0=dead, 3=most vigorous) After First Full Growing Season (1979)-Southwest Center.

Variety	# Plants Rated	#Dead Plants	Average Vigor
Bluecrop	24	0	2.6
Collins	24	0	2.5
Bluetta	24	2	2.1
Coville	24	4	1.1
Earliblue	4	0	2.3
Blueray	4	0	1.5

EVALUATION OF TALL FESCUE AND KENTUCKY BLUEGRASS CULTIVARS FOR LAWN TURF

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Tall fescue evaluation at Columbia includes progeny of selections made during the 1970's. Plots are mowed 1-2 times/ week at 3 inches with a rotary mower. A total of 3 to 4 lb N/ 1,000 sq ft is applied during March, June, September and October. Plots are not irrigated.

Several of the newer tall fescue cultivars and experimentals showed good quality which was equal to or better than that of Kentucky 31 during summer, 1979 (Table 1). Kentucky 31 showed an advantage over most entries in late July during the first interval of heat and drought stress.

Tall fescue plots in southwest Missouri receive only 2 lb N/1,000 sq ft/yr and occasional mowing at 3 inches. Quality of plots in this environment is shown in Table 2.

Breeding goals for 1980-83 continue to emphasize development of tall fescue with low leaf area expansion rates. Seed of experimentals from this group will be harvested during the summer and planted in small, replicated plots near Columbia for evaluation under turf culture. Two Missouri selections are currently being evaluated in Oregon for seed production. Breeding and evaluation of tall fescue continues at 8 locations in Missouri.

Sixty varieties of the Northeast-Midwest Regional Kentucky Bluegrass Study were seeded at Southwest Center in early September, 1972. Plots are 4 x 6 ft and are replicated 3 times. The test receives a yearly total of 2 lb N/1,000 sq ft applied in March and September. Plots are mowed 1 to 2 times per week at 2½ inches. Plots are not irrigated. Quality of cultivars was generally poor during 1979 and most have been heavily infested with <u>Fusarium</u> spp. and/or <u>Rhizoctonia</u> spp. during the past four years. The only plots showing fair (acceptable) quality in summer were Fylking-Biljart (bluegrass-fine fescue) mixes which are now almost 100% Biljart (Table 3).

The same group of Kentucky bluegrass varieties is under evaluation at Columbia. Maintenance is more intense compared to the test in southwest Missouri. Irrigation is applied as needed. Plots receive 3 to 4 lb N/1,000 sq ft per year and mowing is done with a reel mower. Quality of these entries has been consistently higher than those in southwest Missouri with several cultivars showing good to excellent quality during summers. Summarization of results for this study is not complete.

Table 1. Quality (9=best) of tall fescue varieties and experimental selections from late spring to late summer, 1979. Columbia.*

Variety	5/19	6/15	7/9	7/23	8/2	8/17	9/4	9/24	Average
Mo. PCTB	7.5 ab	8.3 a	7.7 ab	4.7 a-e	6.0 a	6.2 ab	6.0 ab	5.3 a	6.5 a
Rebel	8.2 a	7.7 abc	8.0 a	4.7 a-e	5.7 ab	6.3 a	6.2 a	4.8 ab	6.4 a
NJ T-1	8.2 a	8.0 ab	7.5 abc	4.0 cde	5.8 ab	5.8 abc	6.0 ab	5.2 ab	6.3 ab
Mo. H-1	6.7 bcd	6.7 bc	6.8 a-d	6.0 a	6.0 a	5.8 abc	6.2 a	5.0 ab	6.2 abc
Ky.5661-321	7.0 bc	7.0 abc	7.2 a-d	5.7 ab	5.8 ab	5.7 abc	5.7 abc	4.7 ab	6.1 abc
Ky. 31	6.7 bcd	7.7 abc	6.8 a-d	6.0 a	5.5 abc	5.2 c	5.8 abc	4.3 ab	6.0 a-d
NK 5-27	7.2 abc	6.7 bc	7.5 abc	5.3 abc	5.5 abc	5.5 abc	5.5 bc	4.5 ab	6.0 a-e
Kenmont	6.7 bcd	7.3 abc	7.3 abc	4.7 a-e	5.5 abc	5.3 bc	5.8 abc	4.7 ab	5.9 a-e
Mo. H-2	6.7 bcd	7.7 abc	7.0 a-d	5.7 ab	5.5 abc	5.2 c	5.5 bc	4.0 ab	5.9 a-e
NK-5-30	6.8 bc	6.3 c	6.5 bcd	4.7 a-e	5.7 ab	5.8 abc	5.8 abc	5.0 ab	5.8 a-e
Gl-307	6.7 bcd	7.7 abc	6.3 cd	4.3 b-e	5.5 abc	5.3 bc	5.5 bc	4.7 ab	5.8 b-e
Mo. 96	6.3 cd	7.0 abc	6.8 a-d	4.0 cde	5.3 abc	5.2 c	5.5 bc	4.7 ab	5.6 cde
Kenhy	6.3 cd	6.7 bc	6.7 bcd	4.7 a-e	5.2 bc	5.2 c	5.5 bc	4.7 ab	5.6 cde
Mo. V-11	6.7 bcd	7.3 abc	7.0 a-d	3.3 e	5.2 bc	5.5 abc	5.7 abc	3.7 b	5.5 cde
Mo.Surprise	5.7 d	6.7 bc	6.3 cd	5.0 a-d	4.8 c	5.0 c	5.3 c	4.2 ab	5.4 de

* Numbers followed by the same letter are not significantly different according to Duncan's Multiple Range test.

Table 2. Quality (9=best) of tall fescue varieties and experimental selections from late spring to early fall, 1979. Southwest Center.*

Entry	6/14	7/19	8/15	10/18	Average
Ky.5661-321	6.2 ab	7.3	6.0 ab	5.0 a	6.1 a
NK 5-30	6.8 a	5.7 cd	6.3 a	5.0 a	6.0 ab
Gl-307	5.8 ab	6.7 abc	6.0 ab	4.7 ab	5.8 ab
Ky. 31	5.9 bc	5.9 cd	6.1 a	4.9 a	5.7 ab
Mo. H-2	5.7 bc	6.3 a-d	5.8 abc	4.7 ab	5.6 abc
Rebel	5.2 c	7.0 ab	5.8 abc	4.3 ab	5.6 abc
Mo. H-1	5.3 bc	6.3 a-d	5.5 bcd	4.7 ab	5.5 bcd
NJ T-1	5.5 bc	5.7 cd	5.8 abc	4.7 ab	5.4 bcd
Mo. PCTB	5.2 c	6.0 bcd	5.3 cd	5.0 a	5.4 bcd
NK 5-27	5.7 bc	5.5 d	5.8 abc	4.5 ab	5.4 bcd
Kenmont	5.5 bc	5.6 cd	5.3 cd	4.0 b	5.1 cd
Mo. 96	5.2 c	5.3 d	5.5 bcd	4.3 ab	5.1 cd
Kenhy	5.2 c	5.3 d	5.2 d	4.0 b	4.9 d

* Numbers followed by the same letter are not significantly different according to Duncan's Multiple Range test.

Table 3. Average quality (9=best) of 1972 Regional Test Kentucky bluegrass varieties and experimentals, mid-June to early September, 1979, Southwest Center.

Fylking + Biljart	5.2	Parade	3.6	KI-158	3.3
KI-157	4.2	Nugget + Park	3.6	Entopper	3.3
Park	4.2	Baron	3.5	Merion + Baron	3.3
Adelphi + Nugget	4.0	KI-187	3.5	Nugget + Glade	3.3
Ram I	4.0	Merion + Pennstar	3.5	Fylking + Jamestown	3.3
Fylking	3.8	NJP-59	3.4	Plush	3.3
NJP-154	3.8	Delft	3.4	BA 61-91	3.2
Sodco	3.8	Nugget + Pennstar	3.4	Cheri	3.2
Merion + Kenblue	3.8	Vantage + Victa	3.4	Fylking + Pennfine	3.2
Windsor	3.7	NJP-143	3.4	Touchdown	3.2
Monopoly	3.7	Nugget	3.3	KI-131	3.2
KI-143	3.7	Victa	3.3	Rugby	3.1
Kenblue	3.6	Bonnieblue	3.3	Glade	3.1
KI-132	3.6	Galaxy	3.3	BA 62-55	3.1
Merion	3.6	Enoble	3.3	KI-138	3.1
Pennstar	3.6	KI-133	3.3	Enita	3.1
Fylking + Pennlawn	3.6	Vantage	3.3	Brunswick + P-59	3.1
Blend 38	3.6	Sydsport	3.3	Enmundi	2.9
Brunswick	3.6	Majestic	3.3	NJP-140	2.9
Adelphi	3.6	Geronimo	3.3	Campina	2.9

Note: Blends of Kentucky bluegrass and Fescue have reverted to almost 100% fescue; blends of Kentucky bluegrass and perennial ryegrass are still mixed.

WALNUT MULTI-CROP DEMONSTRATION

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Missouri is a leading state in the production of black walnut wood and nut products. Much of this production has come from prairie and row-crop situations. With increasing demands for walnut and decreasing supplies, black walnut values have risen and offer opportunities for supplemental farm income. Management systems are being developed to allow management of walnut trees in conjunction with other cropping systems.

In a cooperative project, the Hammons Walnut Products Company of Stockton, the Forestry Division of the Missouri Department of Conservation, and the University of Missouri School of Forestry, Fisheries and Wildlife established a 160-tree demonstration planting, in fescue pasture, on the Southwest Missouri Center in the spring of 1975.

The planting was made with tree rows spaced 35 feet apart and with the trees 12.5 feet apart within the row. This spacing allows some future selectivity among trees but allows haying or future grazing between the rows.

Genetically superior walnut seed sources were used, chemical weed and grass control was applied around the seedlings, and a fescue hay crop is periodically removed from the demonstration area.

In addition to the demonstration value of the project, the area will serve to provide data about the compatibility of walnut and fescue and on the survival and growth of the superior seed sources.

In spite of a very dry period during the summer and moderate defoliation by grasshoppers, survival on the plantation at the end of the first growing season was 96 percent.

On April 25th, 1976 (second growing season) a killing frost destroyed most of the leaves on all the seedlings. The trees made a good recovery and at the end of the second growing season, the plantation still had 87 percent of its trees surviving. As a result of the freeze, many multiple stems occurred and the need for corrective pruning developed. Also, some evidence of saprophytic fungi has appeared on the stems of some of the walnut seedlings.

Chemical weed control was applied around the seedlings in late April, 1977 (third growing season). The plot was also fertilized in March. Hay cuttings were made in the summer and early fall removing 135 bales in the first cutting and 98 bales in the second on the 1.6 acres.

No chemical weed control was used in 1978 or 1979 (fourth and fifth growing seasons) but the field was again fertilized. Survival increased to 88 percent due to re-sprouting of several trees thought dead in a prior survival count. Of the 19 trees lost since the initial planting, seven were noted to have moldy roots when planted.

The trees were measured in November 1979, for height and diameter growth. At the end of the fifth growing season the average diameter was .96 inches and the average height was 51 inches. The tallest tree in the plantation was 75 inches tall and 1.38 inches in diameter.

The first corrective work was performed on the trees in March of 1980 just prior to their 6th growing season. Trees in rows 1 and 3 (from the north side of the plantation) were not pruned or taped but were left in their natural growing state. Trees needing corrective work were taped or pruned in rows 2 and 4. About 70 trees received treatment which took about 2 hours of time.

SOUTHWEST CENTER SWINE EVALUATION STATION

by

John C. Rea, Keith Leavitt, Department of Animal Husbandry
and Eldon Cole, Area Extension Livestock Specialist

In 1979, 156 boars were tested through the facility at the Southwest Center Swine Evaluation Station. Since the establishment of the swine test station, 1027 boars have been evaluated for 67 different breeders.

The evaluation station was established through the efforts of concerned swine producers in the area in cooperation with Agri-Businesses throughout Southwest Missouri. It includes 30 pens with a lagoon, service building, and boar testing equipment. The day-to-day management of the test station is under the supervision of the Southwest Center staff, with consultation from Keith Leavitt of the University of Missouri, Columbia.

Sales in 1979 were held in January, February, July and August. Animals meeting the standards set up by an advisory group are eligible for sale. About 70% of the boars that go on test qualify for sale. Boars are rated on the traits of average daily gain and feed efficiency and must meet certain criteria on carcass measurements which include backfat and loineye area. The average performance and range for each trait for the 1029 boars that have been on test are included in the following table:

Boar Data for Southwest Center Swine Evaluation Station
(1975-1979)
1027 Head

Trait	Average	Range
Av daily gain (lbs)	2.02	1.40 - 2.77
Feed/lb gain (lb)	2.65	2.21 - 3.18
Backfat (in)	.75	.60 - 1.07
Loineye area (sq in)	5.63	4.71 - 6.86

There have been twenty-one (21) performance tested sales held since the test station was built. Five hundred eighty two boars have been sold for a total of $180,536 for an average of $313 per head. A high percent of boars sold stayed in Southwest Missouri. Slightly over 10% of the boars have been going out of state. Some of these have been top sellers in the sales. Prices have ranged from $150 to $1050 per boar. All costs of the test are paid by the breeders. The floor price last year has been $250.

In addition to the individual data on boars, a pen index system has been used. The index places approximately equal emphasis on feed efficiency, backfat, and rate of gain. Buyers can use the index as one method of evaluating a pig. The index is calculated as follows:

Index - 100 + 60 (DG-ADG) - 75 (FG-AFG) - 70 (BF-ABF)

In addition, a ratio is calculated to allow buyers to determine the performance of an individual boar in relation to the average of all boars on the test.

A top health program is in effect at the Southwest Center. Boars are vaccinated for Erysipelas and Leptospirosis. Boars prior to sale have been blood tested and found to be negative for Brucellosis, Pseudorabies, and Leptospirosis. Sanitation is stressed at the testing station with foot baths and other means to cut down on chances of boars contacting a disease.

Boars are screened for soundness and other traits that may affect his ability to breed. The station veterinarian is a member of the screening committee.

The central test station in this area continues to be of value, both to breeders and buyers. It allows breeders to obtain an evaluation of their animals under a standard environment. It also provides a regulated source of tested boars for Southwest Missouri commercial producers to use in improving performance of both feeder pigs and slaughter weight hogs.

WEATHER DATA FROM SOUTHWEST MISSOURI CENTER,
MT VERNON, MISSOURI, AGRICULTURAL EXPERIMENT STATION FOR 1979-80

AIR TEMPERATURE

1979	Mean Max.	Mean Min.	Average	*Normal	Departure	90 or Above	100 or Above	32 or Below	0 or Below
August	82.0	64.9	73.5	77.2	-3.7	0	0	0	0
September	78.4	54.1	66.3	69.6	-3.3	0	0	0	0
October	72.6	44.6	58.6	59.5	- .9	1	0	6	0
November	53.0	32.0	42.5	46.5	-4.0	0	0	20	0
December	50.2	28.1	39.2	37.0	+2.2	0	0	22	0
1980									
January	42.8	21.1	33.5	34.1	- .6	0	0	25	0
February	40.7	19.6	30.2	37.9	-7.7	0	0	26	0
March	54.6	30.9	42.8	44.6	-1.8	0	0	13	0
April	68.1	41.4	54.8	57.0	-2.2	0	0	4	0
May	74.8	53.0	63.9	65.2	-1.3	0	0	1	0
June	85.5	65.2	75.4	73.7	+1.7	9	0	0	0
July	99.2	71.3	85.3	77.9	+7.4	29	15	0	0

*Mt. Vernon Normal Used

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WEATHER DATA FROM SOUTHWEST MISSOURI CENTER,
MT VERNON, MISSOURI, AGRICULTURAL EXPERIMENT STATION FOR 1979-80

(Precipitation in Equivalent Inches of Water)

Precipitation

	Total	*Normal	Departure
1979			
August	3.78	3.15	+0.63
September	2.33	4.12	-1.79
October	3.72	3.88	-0.16
November	3.27	2.68	+0.59
December	1.00	2.21	-1.21
1980			
January	1.06	1.78	-0.72
February	2.83	2.26	+0.63
March	4.50	3.03	+1.47
April	3.07	4.47	-1.40
May	2.42	5.57	-3.15
June	3.03	5.17	-2.14
July	0.20	3.41	-3.21

*Mt. Vernon Normal Used

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WEATHER DATA FROM SOUTHWEST MISSOURI CENTER,
MT VERNON, MISSOURI, AGRICULTURAL EXPERIMENT STATION FOR 1979-80

Notable Dry Periods after August 1, 1979:
(At least 14 days with less than 0.20 inch precipitation)

	Dates	Length	Precipitation
1979	Sept. 3 - Oct. 17	45 days	.14
	Nov. 22 - Dec. 23	32 days	.17
1980	Jan. 21 - Feb. 4	15 days	.14
	Feb. 16 - Feb. 29	14 days	.13
	Apr. 28 - May 11	14 days	.07
	May 24 - June 15	23 days	.14
	June 24 - July 25	32 days	.05

Occurrence of a Killing Freeze

	Severe $T \leq 24°F$	Moderate $T \leq 28°F$	Light $T \leq 32°F$
First in Fall 1979	Nov. 7	Oct. 10	Oct. 5
Last in Spring 1980	Mar. 14	Mar. 18	May 9

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SUMMARY OF A 3 YEAR (1977-1980) FESCUE FOOT TOXICITY TRIAL AT SOUTHWEST CENTER

George B. Garner and Creighton N. Cornell, Biochemistry Department, UMC; Stan Bell, Southwest Center and Shelly G. Yates, Northern Regional Research Laboratory, USDA, SEA, AR, Peoria, IL

Abstract: Five varieties of tall fescue, Ky-31, Kenhy, Mo-96, Kenmont and Fawn, were winter grazed by steers to evaluate their relative fescue foot toxicity potential. The above order of varieties is reflective of relative toxicity (combined 3 years data). Ky-31 was most toxic in two of the three grazing experiments, while Fawn was consistently least toxic. Average daily gain in these winter trials during the three year period was highly variable due to seasonal differences. There did not appear to be a relationship between gain and relative toxicity. Only one steer developed severe enough symptoms to warrent removal from the experiment. This grazing study and results of our extract infusion studies in cattle at Columbia indicate that new varieties Mo-96 and Kenhy have the potential to cause fescue foot.

The objectives of this study were two fold: 1) to determine, under winter grazing conditions, the relative fescue foot potential of two new fescue varieties, Mo-96 and Kenhy, as compared to Ky-31, Kenmont and Fawn; and 2) to produce toxic tall fescue fall regrowth for extraction and chemical studies to be conducted at Columbia and the Northern Regional Research Center, Peoria, IL.

It should be pointed out that we too were subject to unpredictable weather and modified experiments each year accordingly. We feel the 1977-78 data is best in terms of our research objectives, but the other two years in which we encountered great difficulty in following the research design are probably more indicative of what the farmer may experience from year to year when using these varieties under Missouri's variable winter conditions. The general design of the 3 year trial was as follows:

1. Three 1 acre pasture replications had been established previously for each variety tested. A hay crop would be removed from each in late May and early July.

2. At least 150 lb of actual N, as ammonium nitrate, would be applied in late August to early September. Actual amount applied is reported for each year in the appropriate table.

3. Grazing would commence about January 1 each year after dry matter availability had been determined and 200-250 lb of forage had been removed for making a chemical separation of fescue foot toxin.

4. Steers would be purchased locally and acclimated to the new surroundings during late November to early December. They would be fed hay plus supplement before being randomly assigned to a pasture.

5. The tail tip, ears and coronary bands of each steer would be inspected for signs of previous fescue foot involvement. Following an overnight shrink, each steer would be weighed before being placed on pasture.

6. Repeated observations of each animal would be made to detect any signs of fescue foot over the period of the experiment.

7. A shrunken weight would be taken every 28 days or when practical during inclement weather.

8. At the end of the experiment, a final shrunken weight would be taken and careful examination in the chute for tail tip, ear and coronary band changes would be made.

9. Daily observations and chute observations would be scored, using the following point assignment:

Points	Symptoms in Rear Limbs and Tail
1	Knuckling in one foot
2	Knuckling in both feet or swelling in one foot or tail tip necrosis
3	Swelling in both feet or lameness in one foot
4	Lameness in both feet or coronary band lesion(s) on one foot
5	Coronary band lesion(s) on both feet

1977

Maintenance fertilizer (75-50-50) was applied in early spring. Hay was cut on May 10-15 and again in early July. Stubble was fertilized in August. Ample rains and a good fall growing season supported a growth of nearly 2 tons DM/Acre. Varietal yield differences were small. See Table 1.

Steers had free choice mineral but no supplement was fed during the trial, except hay of the same variety when snow storms occurred. Each animal was offered 76 lb of hay total during the trial (January 4 through April 6, 1978), 40 days of which there was snow cover. Because of the difference in grass available, weight measurements were not reported during the March 1 through April 6 period, but observations for fescue foot were continued.

Table 1. Fescue foot potential comparison of fescue varieties (1977-78).

Variety	Number of Animals	DM Available at Start of Trial (lb) 1/	55 Day Average Daily Gain (lb) 2/	Fescue Foot Score 3/	
				Pasture Observations	Chute Observations
Ky-31	12 4/	4012	0.347	205	54
Kenhy	12	3644	0.550	193	49
Mo-96	12	3835	0.667	121	36
Kenmont	12	4000	0.430	70	46
Fawn	12	3835	0.377	19	30

1/ One hundred-fifty pounds of N, as ammonium nitrate, were applied/acre in late August, 1977. There were 13.86 inches of rainfall between September 1 and November 30, 1977. Data represent an average of 3 replications.

2/ Trial was conducted from January 4 through March 1, 1978.

3/ Trial was conducted from January 4 through April 6, 1978. Pasture observations were made on 32 days, chute observations on March 1 and at end of trial. These data are a numerical evaluation of relative severity.

4/ One animal crippled-removed just prior to March 1 weigh day.

Table 2. Fescue foot potential comparison of fescue varieties (1978-79).

Variety	Number of Animals	DM Available at Start of Trial (lb) 1/	52 Day Average Daily Gain (lb) 2/	Fescue Foot Score 3/	
				Pasture Observations	Chute Observations
Ky-31	9 4/	1307 5/	0.14	133	0
Kenhy	12	1252	0.29	118	0
Mo-96	12	1164	0.28	124	2
Kenmont	12	1434	0.16	128	0
Fawn	12	1116 5/	0.32	77	4

1/ One hundred-ninety pounds of N, as ammonium nitrate, were applied/acre in late August, 1978. There were 10.56 inches of rainfall between September 1 and November 30, 1978. Data represent an average of 3 replications.

2/ Trial was initiated on January 26, 1979, but due to weather conditions animals were removed on January 30, and fed hay. Trial re-initiated on February 15 through March 20, 1979. Data include pasture gain plus gain when all were fed hay during adverse weather.

3/ Trial was conducted from February 15 through March 20, 1979. Pasture observations were made on 13 days, chute observations at end of trial. These data are numerical evaluation of relative severity.

4/ Only 3 animals grazed on each replication due to harvesting of hay for extraction and use in toxicity studies at Columbia.

5/ Average of 2 replications only.

Table 3. Fescue foot potential comparison of fescue varieties (1979-80).

Variety	Number of Animals	DM Available at Start of Trial (lb) 1/	28 Day Average Daily Gain (lb) 2/	Fescue Foot Score 3/	
				Pasture Observations	Chute Observations
Ky-31	12	3767	1.03	130	17
Kenhy	11	3333	0.98	89	2
Mo-96	12	3167	1.15	135	9
Kenmont	12	3967	1.00	157	8
Fawn	8 4/	1967 4/	1.41 4/	48	2

1/ Two hundred-seventy pounds of N, as ammonium nitrate, were applied/acre in late August, 1979. There were 9.32 inches of rainfall between September 1 and November 30, 1979. Two inches of supplemental water were supplied by irrigation during this same period. Data represent an average of 3 replications.

2/ Trial was conducted from December 28, 1979 through January 25, 1980.

3/ Trial was conducted from December 28, 1979 through February 12, 1980. Pasture observations were made on 18 days, chute observations at end of trial. These data are a numerical evaluation of relative severity.

4/ Reduced carrying capacity resulted from grazing of Fawn pastures in August, while others were stockpiled from May 22, 1979. Average daily gain cannot be compared to that of the other 4 varieties because of management imposed.

1978

Maintenance fertilizer (0-50-50) was applied in early spring. Hay was cut in mid May and again in early July. Stubble was fertilized in August. Rainfall was ample but distribution poor and growth of all varieties was reduced to about 0.5 ton DM/Acre.

The steers were not placed on pasture until January 26, 1979 due to snow cover. They were removed January 30 when another storm produced ice and additional snow, making grazing impossible. From January 30 until February 15, 1979 the animals were group-fed switchgrass hay with free choice mineral supplement. Data were collected from February 15 through March 20, 1979 and are summarized in Table 2.

1979

Maintenance fertilizer (0-50-50) was applied in early spring. Hay was cut in mid May. No second cutting was taken in July, so growth was allowed to accumulate from May 22. All pastures were top dressed in late August and received two inches of supplemental water via irrigation between September 1 and November 30, 1979. Fawn pastures were grazed in August due to pasture needs of the center, resulting in a grass supply less than that of the other varieties. Note the average daily gain differences. Because of the difference in grass availability, weight measurements were reported only during the period December 28, 1979 through January 25, 1980. Observations for fescue foot were continued through February 12, 1980. The data are summarized in Table 3.

During the adjustment period, prior to the allotment of steers to pastures, all received medication for a respiratory disease. After allotment to pastures, a few animals were again treated individually when signs of respiratory problems recurred.

Table 4. Summary of fescue foot potential comparisons of fescue varieties (1977-80) 1/

	Year of Observation			
Variety	1977-78	1978-79	1979-80	Total
Ky-31	259	177 2/	147	583
Kenhy	242	118	99 2/	459
Mo-96	157	126	144	427
Kenmont	116	128	165	409
Fawn	49	81	75 2/	205

1/ Each value represents the sum of pasture and chute observations.

2/ Values normalized to represent 12 animals/variety/year.

Conclusions: A summary of fescue foot potential comparisons of five fescue varieties is given in Table 4. The most consistant findings in this three year study were that Fawn was least toxic, while Kenhy, Mo-96 and Kenmont were intermediate in toxicity when compared with Ky-31. Ky-31 was most toxic in two of the three years and was also most toxic based on the total score for the three years.

Dry matter available as fall regrowth and average daily gain of the steers by fescue variety was determined primarily for interpertation of the fescue foot data and not as an animal production/Acre test. While the data are interesting for comparative purposes, it must be remembered that these experiments were conducted to measure fescue foot potential and not to optimize gain.

We will now conduct similar experiments at Columbia, where Ky-31, Kenhy, Mo-96 and Fawn pastures have been established on the University's South Farm.