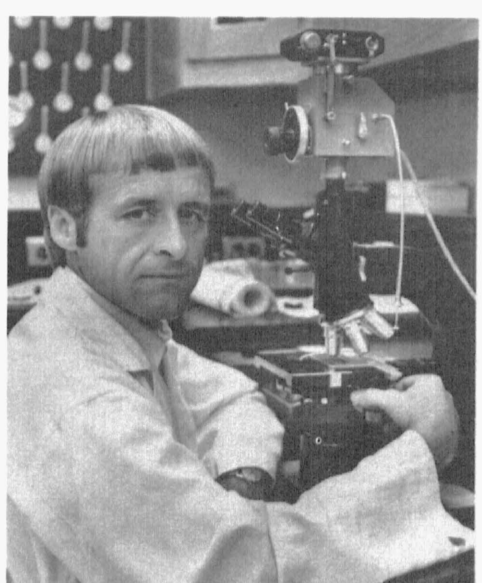
Research Reports 1978

Southwest Missouri Center
Mt. Vernon, Mo.

College of Agriculture
University of Missouri-Columbia

Special Report 215



University of Missouri

AGRICULTURAL EXPERIMENT STATION
Southwest Missouri Center

Route 3
Mount Vernon, Missouri 65712

Science in the Public Service

Area Code 417 466-2148

September 15, 1978

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.

Come see us!

Sincerely yours,

Norman

Norman Justus
Superintendent

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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.

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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. Copies of THE CENTENNIAL REPORT are available from the Editor's Office, 1-98 Agriculture Building, University of Missouri-Columbia, Columbia, Missouri 65211 at a cost of $2.50 each.

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.

The center has been designated the University of Missouri-Columbia Southwest Center and serves as the headquarters for the area extension program as well as the research center.

WEATHER DATA FROM MT VERNON, MISSOURI CENTER
AGRICULTURAL EXPERIMENT STATION FOR 1978

AIR TEMPERATURE

	Mean Max.	Mean Min.	Average	*Normal	Departure	90 or Above	100 or Above	32 or Below	0 or Below
January	29.5	12.2	20.9	32.9	-12.0	0	0	31	2
February	31.8	16.0	23.9	37.0	-13.1	0	0	28	2
March	51.2	30.5	40.9	44.0	- 3.1	0	0	18	0
April	68.6	46.6	57.6	56.5	+ 1.1	0	0	2	0
May	72.7	53.0	62.9	65.1	- 2.2	0	0	0	0
June	82.0	62.8	72.4	73.6	- 1.2	4	0	0	0
July	92.2	69.5	80.9	77.8	+ 3.1	24	1	0	0

*Springfield Normal Used.

COMPILED BY DEPARTMENT OF ATMOSPHERIC SCIENCE
COLLEGE OF AGRICULTURE

WEATHER DATA FROM MT VERNON, MISSOURI CENTER
AGRICULTURAL EXPERIMENT STATION FOR 1978

(All Temperatures in Degrees Fahrenheit and Precipitation in Equivalent Inches of Water)

Precipitation

	Total	*Normal	Departure
January	1.52	1.67	-0.15
February	1.34	2.22	-0.88
March	4.88	2.99	+1.89
April	4.31	4.27	+0.04
May	7.11	4.93	+2.18
June	5.34	4.72	+0.62
July	3.68	3.62	+0.06

*Springfield Normal Used.

Notable Dry Periods Between May 1 and August 1:

Dates	Length	Rain
6/23 - 7/14	22	.12

Compiled by Department of Atmospheric Science
College of Agriculture

PASTURE SYSTEMS FOR SEASON-LONG GRAZING

A. G. Matches, Science & Education Administration,
U. S. Department of Agriculture and Department of Agronomy;
S. Bell and M. Mitchell, Southwest Center;
F. A. Martz, Dairy Husbandry Department

Abstract: The purpose of this research is to develop grazing systems for bridging the summer slump in pasture production.

Pasture systems were grazed from April 7 to December 12 (239 days) during 1977. Average daily gains, gains per acre, and gain per tester animal were not significantly different (P = .05) among the four pasture systems (fescue-fescue baled, fescue-legumes, fescue-caucasian bluestem, and fescue-switchgrass). The fescue-legume and fescue-switchgrass systems had the lowest carrying capacity (animal days and animal unit days per acre).

Fescue-red clover pastures averaged about 4% red clover during the spring and 20% in the fall. Fescue-alfalfa pastures averaged 31% alfalfa from June to September.

Cattle maintained positive gains over nearly the entire grazing season on all pasture systems.

Introduction: This experiment represents phase II of our research in developing grazing systems for bridging the summer slump in pasture production; phase I experiments were completed in 1972.

Pasture systems consist of tall fescue for spring and autumn grazing and perennial summer grasses ('Blackwell' switchgrass and caucasian bluestem) for summer grazing. Also, pastures of tall fescue cut for hay in May and round baled were grazed (regrowth plus round bales) during the summer slump and again in late autumn. The above fescue pastures received an annual fertilization of 75 lb nitrogen per acre in February and 50 lb again in August. Warm-season grasses were fertilized annually with 60 lb of nitrogen in early May.

Two additional fescue pastures which include legumes made up another system. 'Victoria' alfalfa and 'Kenstar' red clover were seeded into established stands of fescue in early March 1974. These pastures were NOT fertilized with nitrogen.

All pastures in this experiment received an annual application of a 0-60-60 fertilizer in February.

Pasture systems being evaluated are:

1. Tall fescue-switchgrass
2. Tall fescue-caucasian bluestem
3. Tall fescue-tall fescue round baled
4. Tall fescue + red clover -- tall fescue + alfalfa round baled

Each pasture system was handled independently of others. That is, components of each system were grazed according to their particular pattern of growth.

Pastures were grazed with Holstein and Guernsey heifers or steers. Tester animals remained on the same system throughout the season and their weight gain indicates quality of forage consumed. The desired balance of defoliation (differs according to the kind of forage) by grazing was maintained through the addition or removal of "put-and-take" animals from a pasture. Cattle were weighed approximately every 14 days and were shrunk 16 hours before weighing. A three-paddock system of rotational grazing was used in all pastures.

Results for 1977: This was the fourth year of grazing these pasture systems. During 1977, grazing began on April 7 and ended December 12 for a total of 239 calendar days of grazing. Dates of grazing the summer pastures are shown in Table 1. Caucasian bluestem was grazed 113 days, the baled fescue and baled fescue-alfalfa 84 days, and switchgrass 98 days.

Hay yields averaged 2416 and 1418 lb of dry matter per acre for the fescue and fescue-alfalfa, respectively (Table 2). Wastage in grazing round bales was nearly the same for fescue and alfalfa and averaged between 15.5 and 13.0%, respectively. Hay samples (Table 3) averaged 55% in vitro digestiblity (IVDMD) shortly after baling and uneaten hay residue in September averaged 37% IVDMD.

Grazing results for 1977 are given in Table 4. The fescue-legume and fescue-switchgrass pastures gave the lowest carrying capacity. Carrying capacity of the other two pasture systems were not greatly different. As in past years, the cattle maintained positive gains over nearly the entire grazing season on all pasture systems.

These experiments were discontinued with the completion of the 1977 grazing season. Future experimental plans include a greater emphasis on the management of fescue-caucasian bluestem systems for higher production per animal and per acre.

Table 1. AVERAGE DAILY GAIN (ADG) OF CATTLE ON SUMMER PASTURE DURING 1977

Species	Dates of grazing	No. of days	ADG lb.
Round baled fescue	6/16 - 9/8	84	0.70
Round baled fescue-alfalfa	6/16 - 9/8	84	1.05
Caucasian bluestem	6/2 - 9/23	113	1.20
Switchgrass	5/19 - 8/25	98	1.43

Table 2. HAY YIELDS, WASTAGE AND UTILIZATION DURING 1977

Hay	Yield 5/6/77 (lb. DM/A)	% Wastage September	Hay utilized (lb. DM/A)
Fescue	2416	15.5	2042
Fescue-Alfalfa	1418	13.0	1234

Table 3. IN VITRO DIGESTIBILITY (IVDMD) OF HAY DURING 1977

	% IVDMD	
Hay	5/25/77[1/]	Residue September
Fescue	53.8	35.1
Fescue-alfalfa	57.4	39.0
Average	55.6	37.0

1/ Sampled following baling

Table 4. GRAZING RESULTS FROM THE PASTURE SYSTEM TRIALS AT THE SOUTHWEST CENTER DURING 1977

Pasture Systems	1977 Grazing Season (April 7 - Dec 12) Animal Days/A	AU Days/A 1/	ADG (lb)	Gain/A (lb)	Grain/Tester (lb)
Fescue - Fescue Baled	292	212	1.35	415	325
Fescue + Red Clover -- Fescue + Alfalfa Baled 2/	227	163	1.44	332	346
Fescue - Caucasian Bluestem	255	198	1.40	379	337
Fescue - Switchgrass	221	172	1.41	335	332
Average	249	186	1.40	365	335
$LSD_{.05}$	40	36	n.s. 3/	n.s.	n.s.
CV %	8.10	9.65	11.43	15.98	10.92

1/ AU Days/A = Animal Unit Days per Acre where a 1000-lb animal equals one animal unit (AU)

2/ Average botanical composition of the legume pastures:
69% fescue - 31% alfalfa
96% fescue - 4% red clover from April 7 to June 16
80% fescue - 20% red clover from September 8 to November 11

3/ n.s. - not significantly different at P = .05

SOD-SEEDING LEGUMES INTO SWITCHGRASS AND CAUCASIAN BLUESTEM

A. G. Matches, Science & Education Administration,
U. S. Department of Agriculture and Department of Agronomy;
and M. L. Mitchell, Southwest Center

Abstract: The establishing of legume stands into old stands of switchgrass and caucasian bluestem by frost seedings is being investigated. Birdsfoot trefoil and red clover were successfully established in both grasses one of the two years seedings were made. Red clover and birdsfoot trefoil may increase total forage production by more than 100% when compared to growing these grasses alone.

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 a 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

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 seedings; but in July 1978, the birdsfoot trefoil and ladino clover stands appeared to have improved. Repeat seedings were made again in 1978.

Plots overseeded in 1976 were harvested as follows: (1) harvesting on a hay-cutting schedule, and (2) harvesting 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.

Total yields of dry matter in 1977 for switchgrass and caucasian bluestem grown alone and with legumes are shown in Table 1. With both warm-season grasses, total yields were many times over 100% higher with 'Kenstar' red clover and 'Cascade' and 'Dawn' birdsfoot trefoil as compared to growing the grasses alone without any nitrogen fertilizer. Under a hay-management system, it appears that red clover may cause reduction in stands of the warm-season grasses because of shading from the canopy of clover. Grass stands remained excellent under the frequent defoliation to simulate pasture conditions.

Yields of dry matter per acre by harvests are shown for the hay and pasture harvests of switchgrass in Tables 2 and 3 and for caucasian bluestem in Tables 4 and 5. Generally, including birdsfoot trefoil or red clover with the warm-season grasses resulted in a more even distribution of forage production over the season than when the grasses were grown alone. 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. These plots will continue to be harvested in 1978 and 1979.

TABLE 1. TOTAL YIELDS FOR SWITCHGRASS AND CAUCASIAN BLUESTEM ALONE AND INTERSEEDED WITH LEGUMES AND HARVESTED AS HAY ON SIMULATED PASTURE. SOUTHWEST CENTER - 1977.

Interseeded Legumes	Total Yield of Dry Matter - lb/A			
	Hay		Pasture	
	Switchgrass	Bluestem	Switchgrass	Bluestem
'Dawn' Trefoil	9986	11207	7972	9254
'Cascade' Trefoil	10386	11582	8923	10655
'Victoria' Alfalfa	5636	6281	4501	4633
'Kenstar' Red Clover	9548	11952	9094	10025
'Arcadia' Ladino Clover	6492	7262	6018	5166
Grass Alone	6830	6704	4771	4595
LSD .05	1188	1561	1188	1561

Table 2. SEASONAL YIELD TRENDS OF 'PATHFINDER' SWITCHGRASS ALONE AND WITH INTERSEEDED LEGUMES UNDER HAY MANAGEMENT. SOUTHWEST CENTER - 1977.

Interseeded Legumes	Yield of Dry Matter - lb/A			
	5/26	7/12	9/19	Total Season
'Dawn' Trefoil	4936	2129	2922	9986
'Cascade' Trefoil	4717	2996	2672	10386
'Victoria' Alfalfa	2702	1243	1690	5636
'Kenstar' Red Clover	5311	1982	2239	9548
'Arcadia' Ladino Clover	2858	1426	2208	6492
Grass Alone	4046	1108	1676	6830

Table 3. SEASONAL YIELD TRENDS OF 'PATHFINDER' SWITCHGRASS ALONE AND WITH INTERSEEDED LEGUMES UNDER PASTURE MANAGEMENT. SOUTHWEST CENTER - 1977.

Interseeded Legumes	Yield of Dry Matter - lb/A					
	Harvest Dates					Total Season
	4/25 or 5/2	6/7	7/12	8/18	9/19	
'Dawn' Trefoil	1826	2385	1551	1062	1148	7972
'Cascade' Trefoil	2321	2584	2182	686	1151	8923
'Victoria' Alfalfa	723	1494	820	885	578	4501
'Kenstar' Red Clover	2256	3104	1595	1118	1021	9094
'Arcadia' Ladino Clover	754	1741	1116	862	1544	6018
Grass Alone	1152	1443	766	856	554	4771

TABLE 4. SEASONAL TRENDS OF CAUCASIAN BLUESTEM ALONE AND WITH INTERSEEDED LEGUMES UNDER HAY MANAGEMENT. SOUTHWEST CENTER - 1977.

Interseeded Legumes	Yield of Dry Matter - lb/A			
	5/26	7/12	9/19	Total Season
'Dawn' Trefoil	3708	3168	4331	11207
'Cascade' Trefoil	4043	3789	3751	11582
'Vcitoria' Alfalfa	1534	2137	2610	6281
'Kenstar' Red Clover	5072	3397	3484	11952
'Arcadia' Ladino Clover	1604	2691	2966	7262
Grass Alone	1701	2400	2602	6704

TABLE 5. SEASONAL TRENDS OF CAUCASIAN BLUESTEM ALONE AND WITH INTERSEEDED LEGUMES UNDER PASTURE MANAGEMENT. SOUTHWEST CENTER - 1977.

Interseeded Legumes	Yield of Dry Matter - lb/A					
	4/25 or 5/2	6/7	7/12	8/18	9/19	Total Season
'Dawn' Trefoil	1747	2644	2240	1082	1540	9254
'Cascade' Trefoil	2188	2693	2910	1032	1833	10655
'Victoria' Alfalfa	686	994	1436	727	790	4633
'Kenstar' Red Clover	2288	2490	2261	1124	1862	10025
'Arcadia' Ladino Clover	542	1080	1512	819	1213	5166
Grass Alone	884	1149	1224	690	647	4595

BIRDSFOOT TREFOIL IN SOUTH MISSOURI

C. J. Nelson, H. N. Wheaton, and I. B. Strong
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 three times during each of 1973, 1975, 1976, and 1977. 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	
pHs	K	T/A	K	T/A	K	T/A	K	T/A	K	T/A
4.7	187	2.45	211	2.48	250	1.39	310	1.36	252	1.39
5.3	181	2.58	189	2.62	225	1.47	272	1.55	227	1.64
5.7	167	2.61	183	2.66	220	1.46	259	1.59	225	1.57
LSD* 0.1	14	0.10	17	0.11	20	ns	28	.13	23	.12

*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
0	0	0	37	33	33	22	19
0	0	50	46	70	77	83	96
0	50	0	51	42	33	26	23
0	50	50	76	110	112	96	103
150	50	0	151	143	92	59	54
150	50	50	200	249	233	213	216
300	50	0	270	316	170	154	110
300	50	50	289	361	364	319	317

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 were available. Orchardgrass was seeded in half the plots as grasses may actually aid persistence of legumes

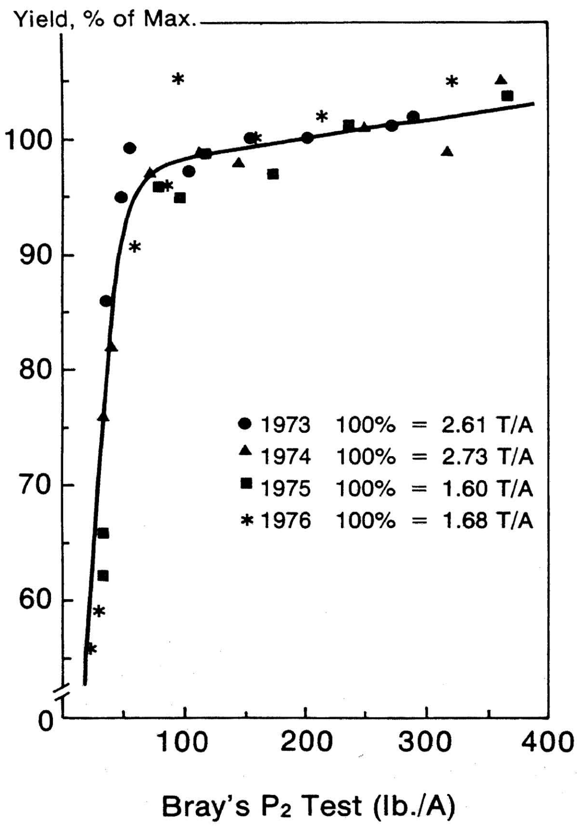

Figure 1. Forage yield of birdsfoot trefoil as affected by soil level of P.

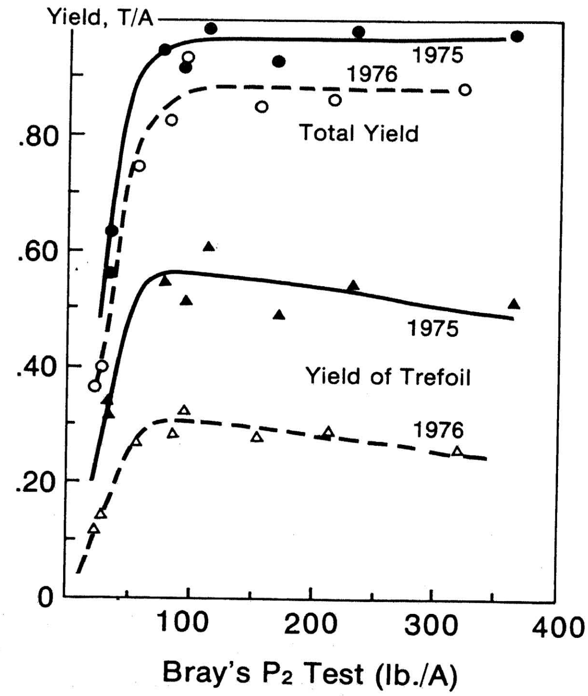

Figure 2. Yield of total forage and trefoil only in first cutting as affected by soil level of P.

by providing a mulch-like canopy in winter and also aid in 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 effects of the treatments had not begun to have a great effect.

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

Cutting Treatment	Code	Forage yield T/A 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
LSD (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)					% Trefoil				
Treatment	1973	1974	1975	1976	1977	1973	1974	1975	1976	1977
15 - FC	1.56	1.89	1.37	1.49	1.69	60.3	35.4	46.6	45.4	45.4
15 + FC	1.92	2.10	1.25	1.38	1.78	60.5	34.8	43.5	44.5	43.9
30 - FC	2.04	2.03	2.21	2.60	2.70	53.8	40.9	44.9	49.9	41.3
30 + FC	2.50	2.40	1.82	2.50	2.86	51.4	40.4	47.2	45.7	43.4
45 - FC	2.76	2.38	2.61	3.38	2.82	67.5	45.8	41.0	53.6	37.8
45 + FC	3.51	2.57	2.80	2.74	2.84	65.3	45.1	49.0	51.3	42.6
LSD .05	0.17	0.15	.32	.60	0.49					
$\bar{x}$	2.38	2.23	2.01	2.35	2.45					

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 reestablishment 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	Spr. 1977	Fall 1977	Spr. 1978
15 - FC	0	0.68	0	0.47	0	0.47	0	.53	0	.33
15 + FC (3)	0.29	0.66	0.18	0.35	.18	0.26	0.02	.39	0.21	.16
30 - FC	0	1.11	0	1.59	0	1.03	0	1.25	0	.66
30 + FC (2)	0.31	1.04	0.24	1.02	.12	0.82	0.03	1.12	0.16	.41
45 - FC	0	1.59	0	1.89	0	2.11	0	1.66	0	1.05
45 + FC (1)	0.72	1.54	0.16	1.86	.25	1.38	0.04	1.47	0.23	0.86
LSD (0.05)	0.12	ns	0.06	0.20	.02	0.48	0.01	.31	0.02	.17

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.

BREEDING TALL FESCUE

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M. L. Mitchell, Department of Agronomy
K. L. Hunt, Department of Agronomy

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

New selections will be planted this fall for progeny testing. Tall fescue clonal lines selected from previous broad-base source nurseries continue to be progeny tested. Selection in these source nurseries has been placed on vigor throughout the growing season, disease resistance, maturity, leafiness, drought tolerance, and winterhardiness. Since these selected clonal lines are now in synthetic combinations, we are dealing with fewer numbers of entries, therefore, more emphasis can be placed on forage quality. The Tilley-Terry *in vitro* fermentation technique is being used to evaluate these new synthetics. A better understanding of the relationships between plant factors and animal performance is needed. We need more detailed information on what chemicals and/or morphological features of tall fescue lend themselves to improving animal performances. Work in this area is being done in cooperation with A. G. Matches (USDA, ARS, Agronomy) and F. A. Martz (Dairy Husbandry) at the Southwest Center.

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 recently 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 broad-based population of 1,000 plants selected for early maturity. We are now in our third 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 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.

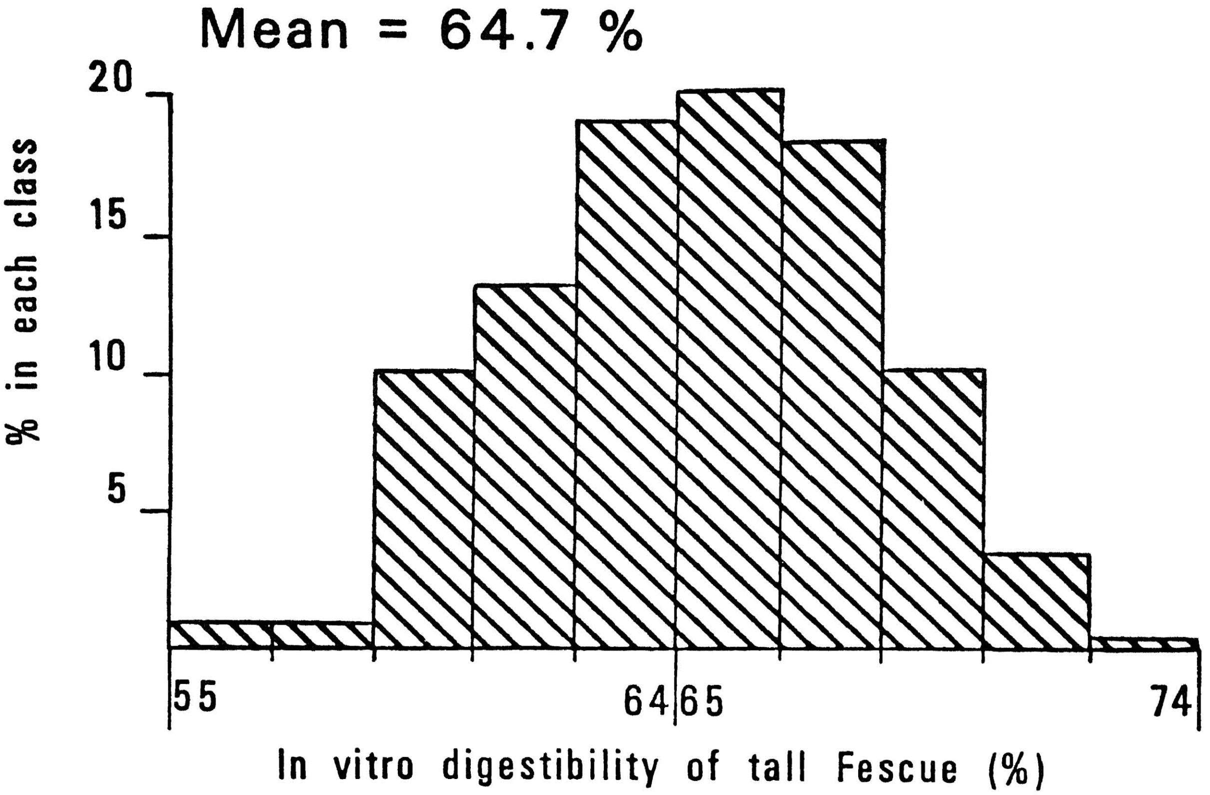
During the past several years, we have put considerable effort into the breeding program to study the genetic variation and heritability of minerals in tall fescue. Improper levels of minerals in forages can cause diseases such as grass tetany in grazing cattle. Grass tetany seems to be a complex problem 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 1 contains heritability estimates for Mg and K/(Ca+Mg) (meq/100 g 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 1. Heritability estimate calculated by the progeny-parent regression method for Mg and K/(Ca+Mg).

Mineral	Year	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. Several cycles of backcrossing and selection for the desired traits may be needed before a superior good seed producing variety can be developed.

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 of 1977. The range for all genotypes was from 55 to 74%. This indicates that there is variation for digestibility in tall fescue. We are trying to utilize this in the breeding program by developing lines that are highly digestible.



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.

BARLEY BREEDING

J. M. Poehlman
Department of Agronomy

Perry winter barley is a new bearded, 6-rowed, winter-hardy, high-yielding variety, released by the Missouri Agricultural Experiment Station in 1977. Perry is earlier, shorter, stiffer-strawed, and has better seed quality than other winter barley varieties available in Missouri. Perry has moderate to good resistance to the barley diseases commonly present in Missouri.

Certified Seed of Perry barley is available for planting in the fall of 1978. Check the Missouri Seed Improvement Association, Fall 1978-Certified Seed Directory, for sources.

Descriptions of Perry, Kanby, and Mo. B-475 varieties follows, with comparisons of performance in six yield trials in Missouri in 1977 and 1978:

PERRY: Perry is a new variety of winter barley released by the Missouri Agricultural Experiment Station in 1977. Perry is an early-maturing, high-yielding, bearded 6-rowed variety. It has short, stiff straw and plump, heavy grain. Perry is winter hardy and resistant to scald, barley yellow dwarf virus (BYDV), Helminthosporium spot blotch, and smut diseases. The early maturity of Perry is advantageous for double cropping with soybeans.

KANBY: Kanby was released by the Kansas Agricultural Experiment Station in 1973. Kanby is a high yielding, bearded, 6-rowed variety. It is short-strawed but lodges more readily than Perry. Seed quality is not as good as Perry. Kanby is resistant to mildew and smut, and moderately resistant to BYDV.

MO. B-475: Mo. B-475 is a bearded 6-rowed winter barley that has been the standard variety in Missouri for many years. Mo. B-475 is taller, lodges more readily, and does not have as good seed quality as Perry. It is resistant to smut and moderately resistant to BYDV and spot blotch.

Comparisons of Winter Barley Varieties in Missouri
(6 tests in 1977 and 1978)

Variety	Yield bu/a	Survival %	Date Headed	Ht. in.	Lodging %	Test wt. lb/bu	Seed Size % on 6/64 Screen	Mildew %	Scald %	BYDV %	Spot blotch %
Perry	60.5	85	5/3	34	13	49.3	61	16	13	14	16
Kanby	63.1	88	5/6	35	30	47.5	58	7	35	20	36
Mo.B-475	48.7	83	5/8	38	29	46.8	46	45	28	25	21

SMALL GRAINS RESEARCH

Boyd Strong, Dale Sechler, J. M. Poehlman, Paul Rowoth and Tim Flanders
Department of Agronomy

Research at the Southwest Center continues with wheat, barley and both winter and spring oats. A few observations involving rye and triticale are also made. Variety trials of all the grains were grown in 1977-78 as well as breeding materials for selection and nurseries for disease and insect evaluation.

The wheat breeding program is directed toward the improvement of yield potential, stability of production and grain quality in soft red winter wheat. Varieties that are short, stiff-strawed and fertilizer responsive with tolerance to the hessian fly and diseases such as Septoria, rust, smut, scab and mildew are desired. Forty populations, hopefully segregating for many of the desired traits, were space planted and selections were made on an individual plant basis in 1978. Forty-one named wheat varieties or selections were also grown in replicated plots as part of the State variety evaluation program. In addition 160 selections were evaluated in preliminary yield trials. The Uniform Hessian Fly Nursery was grown to assess the fly race pattern. Performance of selected wheat varieties is shown in Table 1. Mildew and Septoria leaf blotch were the most damaging wheat diseases present at Mt. Vernon in 1978.

Forty-two spring and 70 winter oat varieties or selections were evaluated at the Southwest Center. Winter killing was minor in the winter varieties and yields were good. BYDV was the most damaging disease. In addition to the replicated yield trials, 200 winter oat observation rows and 19 segregating space planted populations were grown. Over years, the best winter oat variety tested has been Chilocco, an Oklahoma release. Bates and Lang have been better spring oat varieties.

Sixty-five barley varieties and experimental lines were evaluated in 1977-78. These included both 2- and 6-row types. The 2-row types offer malting potential in addition to the traditional barley uses. No malting barley varieties are yet available but Perry, a winter hardy, well adapted, 6-row feed barley, was released in 1977. Performance is given in Table 2.

Comparative performance and descriptions of adapted wheat, oat, and barley varieties are available from extension personnel and in current UMC guides.

Table 1. Missouri Wheat Variety Tests, 3 yr. average 1975-78 (All Outstate Stations*)

Variety	Yield by location: Columbia bu/A	Lamar bu/A	Mt. Vernon bu/A	Portageville bu/A	Overlocations: Yield bu/A	Test wt. lb/bu	Pearled Off %	Dt Hded	Ht in	Lodg %	Septoria Leaf %	Septoria Hd %	Mildew %	Leaf Rust %
Hard Wheat														
Parker	42	45	49	43	44.8	62.1	28	5/ 8	41	20	26	9	52	25
Centurk	51	43	53	48	48.8	60.8	27	11	42	33	29	4	26	8
Sage	50	40	45	41	44.0	61.2	28	13	43	27	25	13	24	24
Larned	53	43	47	43	46.5	61.2	33	12	43	18	19	14	24	14
Soft Wheat														
Arthur 71	46	48	52	39	46.3	60.6	43	7	37	13	25	11	7	3
Abe	55	50	53	46	51.0	59.8	45	7	36	15	31	9	4	5
Oasis	56	51	52	41	50.0	60.2	46	8	39	16	16	9	9	6
BEAU	59	51	53	45	52.0	60.9	42	8	36	8	27	12	9	10
Doublecrop	42	47	45	37	42.8	60.6	44	1	37	10	28	17	16	2
Stoddard	59	50	51	50	52.5	60.5	39	9	42	14	25	6	39	4
Hart	59	58	56	51	56.0	59.5	39	8	38	10	28	8	27	8
McNair 48-23	53	53	48	49	50.8	59.7	39	13	36	9	29	11	25	1
McNair 1003	63	61	67	49	60.0	57.3	46	11	38	10	14	8	4	15
Mo. W9148	60	57	66	56	59.8	59.5	39	8	37	12	18	8	40	8

* The number of outstate trials varied from 4 to 6 but the average performance for each year is included in the calculations.

Table 2. Comparisons of Winter Barley Varieties in Missouri (tests in 1977 and 1978)

Variety	Yield bu/A	Surv %	Dt Hded	Ht in	Lodg %	Test wt lb/bu	Seed Size % on 6/64 Screen	Mildew %	Scald %	BYDV %	Spot Blotch %
Perry	60.5	85	5/3	34	13	49.3	61	16	13	14	16
Kanby	63.1	88	5/6	35	30	47.5	58	7	35	20	36
Mo B-475	48.7	83	5/8	38	29	46.8	46	45	28	25	21

FURTHER UTILIZATION OF VARIETY TESTING FIELDS

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Abstract: The corn hybrid test fields are being used this year for two purposes other than variety trials. The first purpose evolved around the testing of a limited data corn yield model. The second purpose involves the taking of complete data sets. Both purposes will be reviewed after the examination of the first year's data to determine if this work is worthwhile.

Historically, the corn hybrid test fields have been used to determine how each variety reacts to different locations and climatic conditions. These fields are planted at the outlying centers of the University of Missouri as well as the cooperating farmers' fields. This year the Southwest Center and the other University of Missouri outlying centers hybrid test fields are being used in an expanded manner. This expansion is essentially in two phases. The first phase is the testing of a limited data corn yield model (Leeper et al. 1974). The second phase is the use of these fields to develop a complete data set for corn.

The Leeper et al. (1974) corn model was developed from field plot data taken from four locations in three years in Illinois. The variables to run this model are plant available soil moisture at planting time, weekly average maximum temperature, weekly total precipitation and the tasseling date. The plant available soil moisture samples were taken after emergence utilizing a Giddings Hydraulic Probe mounted on a pickup truck. The samples were taken at 4 inch increments to a depth of 4 feet. These samples were individually bagged and brought back to the lab to be weighed and dried and reweighed. Other tests will be run on these particular samples. The temperature and precipitation measurements are being taken by station personal. The tasseling date is also being taken by station personal. The model utilizes 10-weeks, 6 weeks before tasseling and 4 weeks after tasseling, of temperature and precipitation data. Thus, the temperature and precipitation data will be used only for that 10 weeks period. Five varieties that are commonly grown in Missouri were selected from these trials and soil moisture measurements were taken on all three replications of these five varieties.

The second phase of this work is to begin building a complete data set on corn. This data set should include soil data, weather data, crop phenology data, as well as yield data. As can be seen from the above paragraph and the normal data taken from the test field, some of these observations already being made. The major missing observation is the phenology measurements. After examining the first year's data, this portion of the study will be reevaluated to determine whether this work is worthwhile.

Leeper, R.A., E.C.A. Runge, and W.M. Walker. 1974. Effects of plant available stored soil moisture on corn yields. II. Variable climatic conditions. Agron. J. 66:723-733.

HERBICIDES FOR ROW CROPS

L. E. Anderson
Department of Agronomy

The weed control demonstration includes herbicides that area recommended by the University of Missouri Agricultural Experiment Station for use on corn, soybeans and grain sorghum. Plots include four 82 foot rows that make up an area of three square rods. The stake sign is located between the two middle rows. Weed control is due to activity of the herbicide application alone - no cultivation or hand hoeing has supplemented the herbicide performance.

Following are the herbicides that were applied, together with rates of application:

CORN DEMONSTRATION
1978

	Herbicide	Rate/Acre	Amt./Plot
PPI	1. Dual + Aatrex	2 pt. + 1.25	18cc + 14 gr.
	2. Eradicane	4.0	48cc
	3. Eradican + Atrazine	2.5 + 1.25	30cc + 14 gr.
	4. Eradican + Bladex	2.5 + 1.25	30cc + 14 gr.
	5. Sutan + Atrazine	3.0 + 1.25	36cc + 14 gr.
	6. Sutan + Bladex	3.0 + 1.25	36cc + 14 gr.
PRE	7. Dual	3 pt.	27cc
	8. Dual + Aatrex	2 pt. + 1.5	18cc + 18 gr.
	9. Lasso + Atrazine	1.5 + 1.5	27cc + 18 gr.
	10. Lasso + Bladex	1.5 + 2.0	27cc + 23 gr.
	11. Lasso + Lorox	1.5 + 0.75	27cc + 14 gr.
	12. Prowl	2 qt.	36cc
	13. Prowl + Atrazine	1.5 qt. + 1.5	27cc + 18 gr.
	14. Prowl + Bladex	1.5 qt. + 2.0	27cc + 23 gr.
	15. Princep	2.5	27 gr.
POST	16. Atrazine + Lasso	2.0 + 1.5	22 gr. + 27cc
	17. Banvel + 2,4-D amine	.25 + .5	45cc + --
	18. Bladex	3.0	32 gr.
	19. Check	--	--

76 rows - 82 ft. long

30" spacing

Location: S.W. Center

Corn planted: May 15

Herbicide appl: May 16

SOYBEAN DEMONSTRATION
1978

Herbicide	How Applied	Rate/acre
1. Cobex	Pre-plant Inc.	0.5 lb.
2. Basalin	Pre-plant Inc.	1.25 lb.
3. Prowl	Pre-plant Inc.	1.0 lb.
4. Tolban	Pre-plant Inc.	1.0 lb.
5. Prowl + Sencor	Pre-plant Inc.	1.5 pt. + 0.5 lb.
6. Tolban + Sencor	Pre-plant Inc.	1.0 pt. + 0.5 lb.
7. Treflan + Sencor	Pre-plant Inc.	0.75 lb. + 0.5 lb.
8. Prowl + Sencor	Sequential	1.5 pt. + 0.5 lb.
9. Tolban + Sencor	Sequential	1.5 pt. + 0.5 lb.
10. Treflan + Sencor	Sequential	1.0 lb. + 0.5 lb.
11. Vernam + Dyanap	Sequential	2.0 pt. + 3.0 lb.
12. Amiben	Pre-emergence	3.0 lb.
13. Dyanap	Pre-emergence	4.5 lb.
14. Sencor	Pre-emergence	1.0 lb.
15. Dyanap + Lasso	Pre-emergence	3.0 lb. + 1.5 lb.
16. Lasso + Sencor	Pre-emergence	1.5 lb + 0.75 lb.
17. Maloran + Lasso	Pre-emergence	1.5 lb + 1.5 lb.
18. Surflan + Sencor	Pre-emergence	1.5 lb + 0.75 lb.
19. Basagran	Post-emergence	1.0 lb.
20. Dinoseb	Post-emergence directed	2.0 lb.
21. Lasso + Lorox	Pre-emergence	1.5 lb + 0.75 lb.

Location: S.W. Center

Beans planted June 1

Herbicides applied June 2

Post-emergence applied June 14

GRAIN SORGHUM DEMONSTRATION
1978

Plot No.	Herbicide	Rate/Acre	Amt/Plot
1	Ramrod	4 lb	53 gr
2	Ramrod-AAtrex	2 lb + 1 lb	26 gr + 14 gr
3	Milogard	2.5 lb	35 gr
4	Igran	3 lb	42 gr
5	Igran + AAtrex	2 lb + 1 lb	28 gr + 14 gr
6	Igran + Milogard	2 lb + 1 lb	28 gr + 14 gr
7	Check	--	--

28 rows - 82 ft long

30" spacing

Location: S.W. Center

Sorghum planted: June 13

Herbicide appl.: June 14

HERBICIDE TREATMENTS TO DORMANT ALFALFA

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Science and Education Administration, U. S.
Department of Agriculture and Department of Agronomy

R. Mattas
Southwest Center

Objective: This experiment was planned to evaluate the effects of herbicides on weeds and alfalfa when the herbicides were applied in the dormant season. Most of the herbicides evaluated injure foliage of alfalfa and some may be translocated through alfalfa leaves, but injury can usually be avoided if the herbicides are applied before the alfalfa begins growth in spring.

Procedure: Alfalfa was treated on February 18, 1977. The number of alfalfa plants were counted in four 6 by 36-inch graduates randomly placed in each plot. The control of cheat grass was estimated and given ratings ranging from 1 to 9. The poorest control was given a ranking of 1, and the best control a ranking of 9.

Results: Herbicides did not cause any large reduction in stand of alfalfa. All rates of paraquat were poor for controlling cheat grass in alfalfa (Table 1). The 1 lb.-rate of simazine, 1 and 2 lb.-rates of pronamide and all rates of Sumitol and metribuzin ranked high in control of cheat grass.

Yields of alfalfa were lowest (Table 2) on the check plots due to the high amount of cheat grass. Yields of cheat grass were high and affected alfalfa yields on plots that were treated with paraquat.

Total yields of alfalfa tended to be low wherever grass yields were high in the first cutting. Herbicides did not noticeably cause any reductions in alfalfa yields.

Table 1. Numbers of alfalfa plants and rating of weed control after treatments with herbicides during the dormant season.

Treatments	Herbicide lb/A	Alfalfa plants/ 1.5 ft.^{2}	Cheat grass rating 6-9-77
Paraquat	½	8	4
Paraquat	3/4	10	3
Paraquat	1	8	4
Simazine	½	10	2
Simazine	1	10	1
Pronamide	½	10	2
Pronamide	1	10	1
Pronamide	2	10	1
Sumitol	1	10	1
Sumitol	1½	11	1
Metribuzin	½	12	1
Metribuzin	1	11	1
Check		8	1

Ratings are 1-poor control to 9-good control.

Table 2. Yields of oven dry alfalfa and weeds in tons per acre on May 10, 1977.

Treatments	Herbicide lb/A	Alfalfa T/A	Weed grass T/A	Broadleaf weed T/A
Paraquat	½	1.5	.40	0
Paraquat	3/4	1.5	.43	.05
Paraquat	1	1.4	.48	.04
Simazine	½	1.6	.21	.02
Simazine	1	1.7	.02	.0
Pronamide	½	1.9	.01	.01
Pronamide	1	1.9	0	0
Pronamide	2	1.9	0	0
Sumitol	1	1.9	0	.02
Sumitol	1½	1.8	0	.0
Metribuzin	½	2.0	.03	0
Metribuzin	1	1.5	.01	0
Check		1.1	.92	0

Table 3. Yields of oven dry alfalfa during 1977 after herbicide treatments.

Treatments	Herbicide lb/A	Yields of alfalfa 5-10 T/A	6-9 T/A	7-13 T/A	9-19 T/A	Total T/A
Paraquat	½	1.5	1.09	1.58	1.08	5.25
Paraquat	3/4	1.5	1.14	1.71	1.22	5.57
Paraquat	1	1.4	1.04	1.68	1.07	5.19
Simazine	½	1.6	1.15	1.63	1.10	5.48
Simazine	1	1.7	1.19	1.67	1.15	5.71
Pronamide	½	1.9	1.24	1.68	1.10	5.92
Pronamide	1	1.9	1.20	1.73	1.14	5.97
Pronamide	2	1.9	1.18	1.72	1.10	5.90
Sumitol	1	1.9	1.22	1.72	1.17	6.01
Sumitol	1½	1.8	1.18	1.62	1.02	5.62
Metribuzin	½	2.0	1.30	1.71	1.10	6.11
Metribuzin	1	1.5	1.11	1.64	1.09	5.34
Check		1.1	1.06	1.67	1.09	4.92

SOIL FERTILITY RESEARCH WITH FORAGE CROPS

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Introduction

The fertilizer topdressing studies on switchgrass and bluestem warm season grasses were terminated, fall of 1977, after running for six and five years, respectively. The soil of all plots was sampled by one-inch depths to a depth of six inches in October, 1977. These samples have been tested and will be summarized soon. Representative yields for 1977 are given in Table 1.

The limestone topdressing study will be terminated in October, 1978 at which time the soil of all plots will be sampled by one-inch depths to a depth of six inches and comparisons between yields, lime levels and soil test values will be made. Yields for 1977 are given in Table 2.

The study using birdsfoot trefoil as a source of N for fescue seed and forage production will continue through 1979. Yields for 1977 are given in Table 3.

Results

Rainfall for the 1977 growing season was almost ideal for growth of forage crops. The average for months March through September was 5.5 inches with 8.1 inches in June and 9.9 inches in September. The lowest amount was 2.9 inches in July.

A. Effect of Topdressing Fertilizers on Yields of Blackwell Switchgrass and Caucasian Bluestem.

These studies use the "Feed the Plant" approach to forage production rather than the conventional "Fertilize the Soil" method used for row and rotated crops. Yield data were taken first in 1972 for the switchgrass and in 1973 for the bluestem. Topdressed fertilizers are composed of 3 levels of N, 4 levels of P_2O_5, and 4 levels of K_2O in all combinations making a total of 48 different treatments. Quantities per acre of the three nutrients are: N=0, 60, 120; P_2O_5=0, 30, 60, 320 as rock phosphate; K_2O=0, 50, 100, 150. Yields for 1977 of selected treatments are given in Table 1.

TABLE 1. Yields of Switchgrass and Bluestem as Influenced by Different Rates of N.P.K. 1977.

Yields T/A					
Selected Treatments	Switchgrass	Bluestem	Selected Treatments	Switchgrass	Bluestem
0 + 0 + 0	1.1	1.7	120 + 30 + 50	5.6	6.5
60 + 0 + 0	2.8	3.7	120 + 30 + 100	5.6	6.5
120 + 0 + 0	3.5	4.8	120 + 30 + 150	6.3	7.4
60 + 30 + 0	3.0	3.7	120 + 60 + 150	5.6	6.5
120 + 30 + 0	4.1	5.5	120 + 320*+ 100	5.5	5.8
60 + 30 + 50	3.8	4.8	120 + 320*+ 150	5.2	5.8
60 + 30 + 100	3.7	4.3			
60 + 30 + 150	3.9	4.5			

* Applied as rock phosphate topdressed spring of first production year of each grass.

The data continues to show that 120 lbs N will produce more forage than 60 lbs N although in some years there is evidence of some carryover from the 120 lbs rate, indicating that 100 lbs N could be a more suitable rate. P_2O_5 at 30 lbs/A and K_2O at 50 lbs/A annually would be optimum rates for these nutrients on this soil. However, yields are tending to be higher with the 150 lbs/A rate. In these studies all forage is removed. Under pasture conditions considerable amounts of the nutrients would be returned in animal wastes and consequently annual P_2O_5 and K_2O applications would be less. Apparently the rock phosphate is not supplying P at an adequate rate for these grasses to produce maximum yields under the good rain fall conditions this year.

B. Method and Rate of Supplying Limestone to Tall Fescue

This study consists of a comparison of four limestone treatments as main blocks (0, 3T and 6T topdressed, 8T plowed down) and five N, P, K treatments topdressed annually on each of the limestone blocks. The variables in these treatments are rates and times of application; total annual quantities of nutrients are equal. Treatments are evaluated by comparing yields as tons/acre hay and P, K, Ca and Mg content of the forage in spring and fall.

The 8T/A limestone treatment was applied (4T plowed down, 4T disked into plowed surface) and the fescue seeded in the spring of 1972 using a 60 + 30 + 30 starter fertilizer. The 3T and 6T limestone treatments were topdressed in May 1973. The annually topdressed treatments are as follows:

Treatment	Time of Application		
	December	After 1st Harvest	August
1	80 + 50 + 150	0	80 + 0 + 0
2	80 + 25 + 75	0	80 + 25 + 75
3	80 + 50 + 75	0	80 + 0 + 75
4	80 + 0 + 0	0	80 + 50 + 150
5	0	80 + 25 + 75	80 + 25 + 75

TABLE 2. Yields T/A of Tall Fescue Related to Limestone and N, P, K Top-dressings, 1977.

	Yields T/A			
NPK Treatment	No Lime	3T Topdressed	6T Topdressed	8T Plowed Down
1	3.9	4.0	4.1	4.4
2	3.8	4.0	4.2	4.5
3	3.8	4.3	4.3	4.5
4	3.8	4.1	4.2	4.3
5	4.1	4.0	4.2	4.5
Average	3.9	4.1	4.2	4.5

The yields in 1977 were nearly double those of 1976 and show that plots that received 3T and 6T/A limestone topdressed in March 1973 produced slightly higher but not statistically different yields than plots getting no limestone. Plots having 8T/A limestone worked into the plowed layer in 1972 show 0.6T/A increase over plots getting no limestone. This is a statistically significant yield increase but probably would not be worth the expense of plowing up a stand of tall fescue to make limestone applications according to tests made on the plow layer.

Initial Soil Test Values, 1972.

Depth	om %	P_2O_5 P_1	Lbs/A P_2	E_xK Lbs/A	Ca Lbs/A	Mg Lbs/A	NA Me/100gm	pHs	CEC Me/100gm
0-7"	2.6	22	20	154	2025	161	6.1	4.7	12.0
8-14"	2.0	10	10	135	1200	257	12.1	3.9	17.1

C. Birdsfoot Trefoil as a Source of N for Fescue Seed Production

Missouri produces more fescue seed than any other state; 70,560,000 lbs of seed were produced in 1976 and 74,925,000 lbs in 1977. This study was stated to evaluate birdsfoot trefoil as a source of nitrogen for fescue seed production and its own contribution as a forage plant grown in combination with tall fescue. Tall fescue seed was drilled into a good stand of Dawn birdsfoot trefoil in fall of 1973. In addition to evaluating birdsfoot trefoil as a nitrogen fixer the study was designed to evaluate the P and K needs of the fescue-birdsfoot trefoil mixture. Treatments and forage and seed yields for 1977 are given in Table 3.

TABLE 3. Effect of Commercial Nitrogen and Birdsfoot Trefoil on Tall Fescue Seed Production and Fescue--Trefoil Forage Yields*

Treatment	Forage T/A 1977	Seed Lbs/A 1977
Fescue alone	1.7	250
Fescue + Trefoil	3.6	300
Fescue + Trefoil + 50 lbs N	2.7	490

*Average of all P, K, levels.

Good stands of trefoil were present on all fescue-trefoil plots during the summer and fall of 1976. However, only enouch N was added to the soil to produce 50 lbs of fescue seed in 1977. Fifty lbs of N in March produced an additional 190 lbs of seed. The trefoil stands appeared to be thinner the summer and fall of 1977. However, there were very good stands of trefoil in 1978. The relatively small amount of nitrogen supplied to the fescue for seed production indicates this fescue-legume combination might not be a good one where fescue seed production is the major item.

D. Red Clover Seed Production

The high price of N in 1973 stimulated interest in use of legumes in pastures, especially red clover, as fixers of N for forage production. This expected increase in demand for red clover seed encouraged studies relating to:

1. Honey bees as red clover pollinators.
2. Time of removal of first cutting on red clover seed production.
3. Effect of P and K topdressings on yield of red clover seed.
4. The value of tall fescue-red clover mixture as a source of quality horse hay as well as a red clover seed crop.

Pure red clover stands were obtained at the Southwest Center and the North Missouri Center and red clover-tall fescue stands were obtained at the Southwest Center and at Bradford Farm, Columbia in 1977. Data are incomplete for 1978 at all three locations.

ALTERING FORAGE MAGNESIUM WITH SOIL TREATMENTS

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Abstract: The crop year 1978 will be the last year of this study and the Southwest Center Research Reports in 1979 will carry a complete summary of the study. The data indicate at this time that top-dressing of tall fescue can be done in May rather than earlier in the year without serious loss in drymatter production. The resulting spring forage will be less likely to be prone to increasing the possibility of grass tetany as indicated by chemical analysis.

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.

Methods

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.

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, after being leached by fall precipitation, the fall growth was removed, dry matter yields were determined and the material analyzed for K, Ca and Mg. (The January harvests are considered as yield of the previous calendar year.) The "February" treatment was applied after removal of the stock piled material. In the spring when new growth reached a 5-inch leaf length, grab samples from each plot were taken at intervals and analyzed for K, Ca and Mg. The entire growth was harvested at initiation of seed head emergence for yield and analysis. No grab samples were taken after the first harvest until fall. 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 and the "August" treatment was applied. After the first frost periodic grab samples were taken until growth ceased. The plant material was dried, ground and analyzed by routine methods.

Results

The 1978 crop year will be the last of this field study. Previous Southwest Center Research Reports have indicated that delaying the spring application of N, P and K until May does not significantly lower annual drymatter production. There has been a shift to greater drymatter production in late May and June than when the fertilizer was applied in late winter or early spring. An additional benefit of the later fertilizer application is the chemical indicator for tetany prone forage suggests the early spring growth would be less likely to cause tetany when compared to the forage which had received the early spring treatment.

No numerical results are presented here as work is underway to evaluate the data from all 6 crop years of the study. At this writing the data presented in the 1976 and 1977 Research Reports showed the relative treatment effects.

NON-CONVENTIONAL SOIL AMENDMENTS

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Soil activators, soil conditioners, plant stimulators, soil surfactants, soil inoculants, "natural" minerals, liquid lime replacement materials, seaweed, fermented manures, crushed mineral (rock) materials, humic materials, and even coal-like materials are among the non-conventional products being offered for sale to farmers. Such products have been around for quite some time but seem to be increasing in numbers in recent years.

The promoters of these products often make fantastic claims for their beneficial effects on soils and crop growth. They are sometimes billed as "cure-alls" which can be good for nearly anything that might ail a soil or plant. They may also be recommended as a livestock feed additive and claims may be made for improving the nutritive value of both feed and food crops. Last winter I read a claim that the use of a seaweed product foliarly on corn in 1976 overcame the effects of drought and tripled corn yield.

Promotional material for one product called a soil conditioner and plant stimulator, claims it will, "--cut the use of fertilizer in half or eliminate it altogether--, revitalize worn out soils and eradicate root rot in such agricultural crops as cotton." It further claims to, "--release nutrients bound in the soil, --reduce caking characteristics in soil and build soil structure, --improve root growth, stimulate circulation in the plant, and provide trace minerals to plants." As if that wasn't enough it is further claimed to, "--adjust soil pH to a favorable range." In my opinion, any product that could do all of these, is truly a miracle!

Sales promotions are usually based largely on testimonials from farmers that supposedly have "successfully" used the product. There is an absence of scientific research to support the claims. If research is quoted, it is often taken out of context, incomplete, and attributed to someone in a distant state. Credibility is sometimes based on quotes from "experts" who probably have no expertise whatsoever in agronomy. Such "experts" may include M.D.'s, veterinarians, lawyers, and even television personalities. Their involvement may be financial backing and are probably well-meaning, but are largely uninformed in the fundamentals of soil chemistry, soil physics, soil fertility, and plant physiology.

When asked how their products can produce the remarkable results they claim, the promoters often answer, "We don't know why, but it works". They may suggest it is due to some "unknown" natural process or ingredient, or perhaps that the ingredients and how they work must be kept secret to protect their investment. Another approach is to use a conglomeration of scientific terms in a sales pitch, which may sound legitimate to laymen not trained in the sciences necessary to fully understand such terminology.

Promoters are usually very vocal critics of agronomic researchers in universities, the U.S.D.A., and large corporations. They will probably tell you, "The university doesn't know it works because they haven't tested our product." Some may also claim universities won't recommend it because they are "controlled" by the large corporations. Another common characteristic of some promoters is the claim that they want to rid agriculture of its dependence on pesticides and inorganic fertilizers, replacing them with their "natural, organic" products.

The "miracle" products are usually used in very small quantities on an acre basis, some as little as 2 ounces per acre. Claims for one product are that 2 to 3 gallons of it will produce the same soil acidity neutralizing benefits as one or more tons of agricultural limestone. This seems rather unlikely. Skepticism is also cast on the claims that these products variously produce the following benefits: chelation of plant nutrients, improve soil water absorptive and holding capacity, increase numbers of earthworms and microbes, increase microbial activity, add beneficial microbes to soil, improve soil organic matter, eliminate crop disease, reduce insect infestation, increase root growth, and improve crop quality.

So-called "proof" of positive results from farmers fields can easily be based on erroneous conclusions. For example, if you have two fields and use a product on one field and not the other and the yield turns out higher where you used it, you might conclude the product produced the benefit. Such, however, is not necessarily the case. There are many other factors which may have caused the difference. Unless the comparison is based on sound scientific principles, the results cannot be considered very reliable. Further, with the normal variations in any field, any series of field trials not properly designed can show what would appear to be a "response" in as many as one-half the trials, regardless of what treatment is applied. This gives the promoters their "ammunition", and they tend to "forget" abount the trials where no response is shown.

A bad crop year, such as the one we had in much of Missouri during 1976, also sets the stage for "proof" that a product works. For example, let's say a farmer used a "miracle" product for the first time in 1977, and gets a very high yield, of course much better than in 1976. It's likely he could be convinced that at least part of that big yield increase was due to the product, when in fact it's more likely due to a better season.

There are too many of these products to conclusively test them all by sound research procedures. The limitations on dollars for agronomic research at the agricultural colleges prevent doing everything that might be needed, and there are higher priorities than testing "miracle" products. Therefore, judgments have to be made based on scientific knowledge and a limited amount of research which has been done on such products. The research which has been done in various states by competent agronomic researchers does not support most of the claims being made for most "miracle" products. Further, the vast amount of scientific expertise available within the ranks of agricultural researchers nationwide, has not found validity in most of the claims for such products.

SOILS OF SOUTHWESTERN MISSOURI

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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.

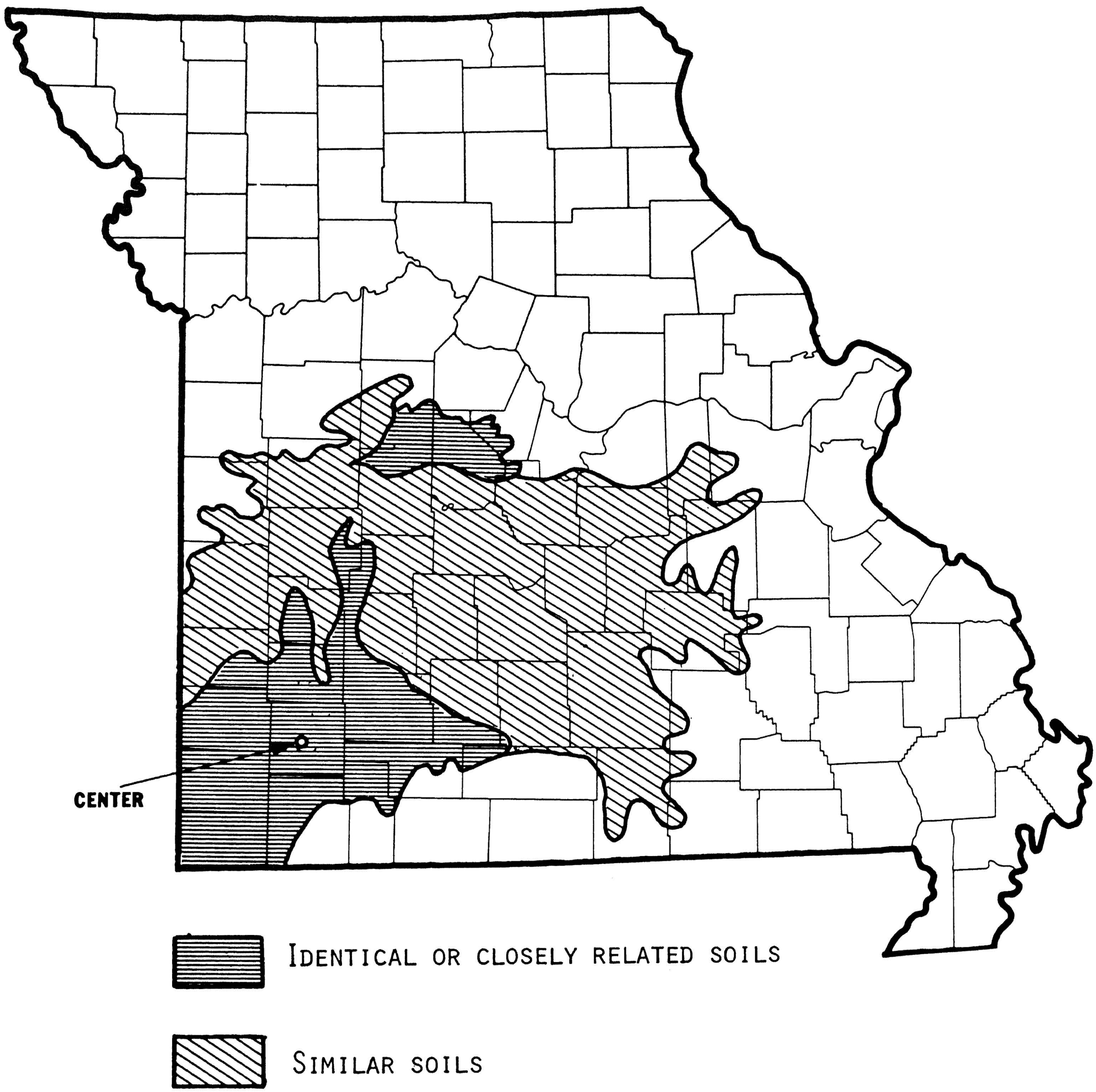
Three soils of the gently sloping prairie uplands were studied in detail. Those soils, named the Gerald, Creldon and Keeno form most of the landscape on the western portion of the lands of the Center. Those same soils are prominent parts of the landscape in that part of Missouri shown in Figure 1 to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

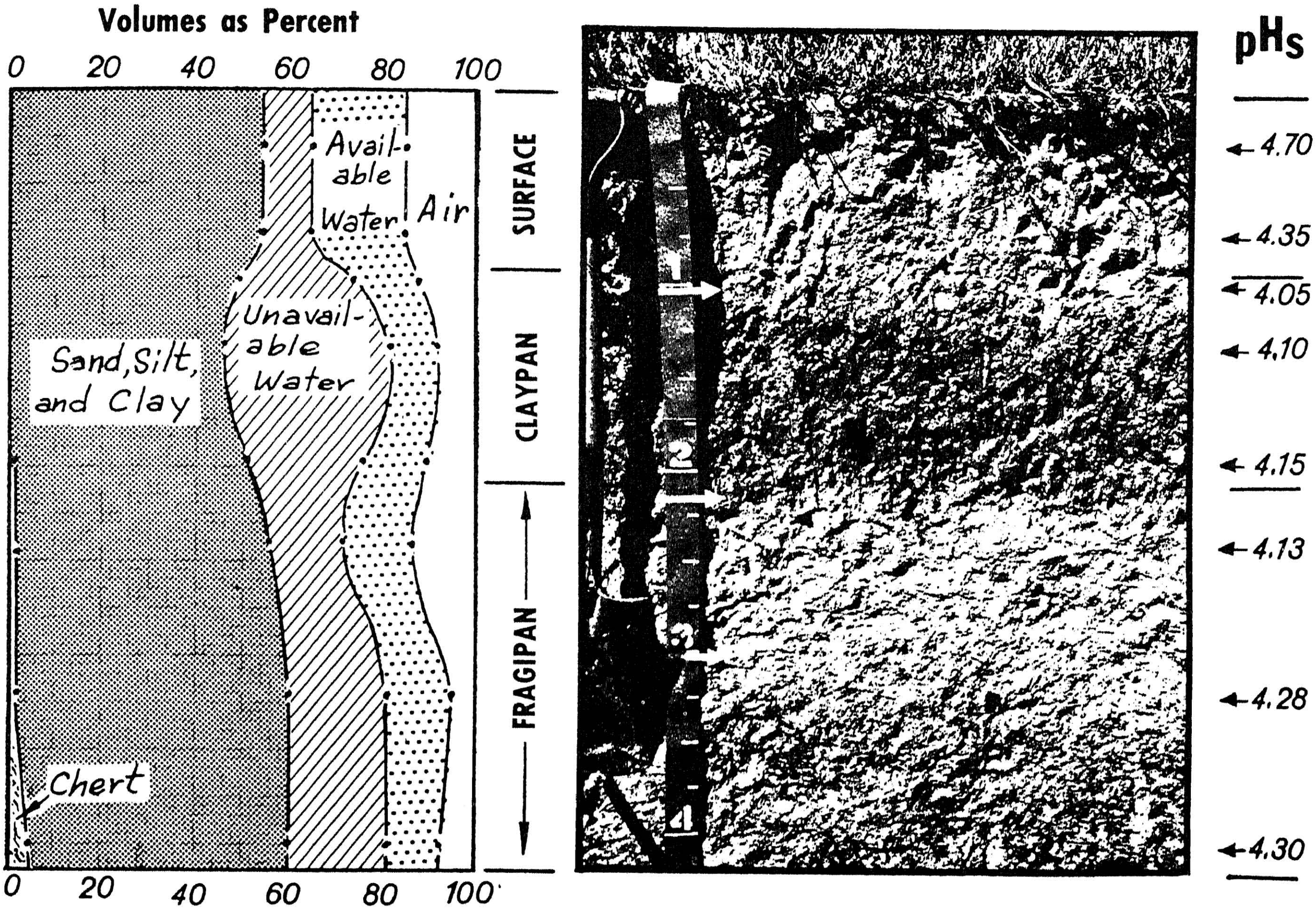
Liming of the subsoils concurrent with mechanical mixing or chiseling might raise the subsoil pH above a critical level and thus encourage root penetration.

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



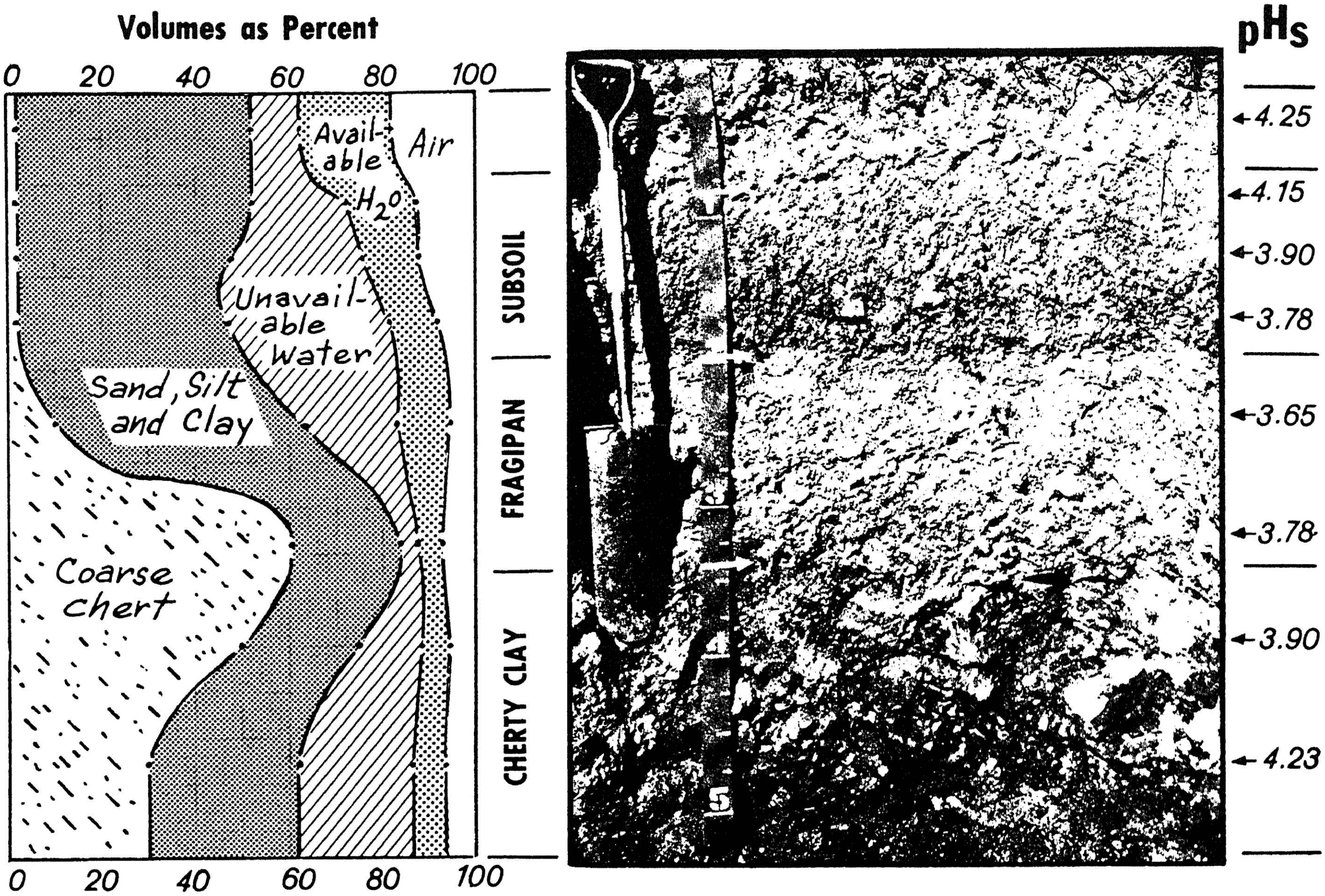
The Gerald soils have dark colored, silty surface horizons underlain by claypan horizons which have as much as 50 to 60 percent clay sized particles. They have fragipans (dense acid layers) below the claypan. Some small chert fragments are scattered throughout materials below the claypan and at some 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.

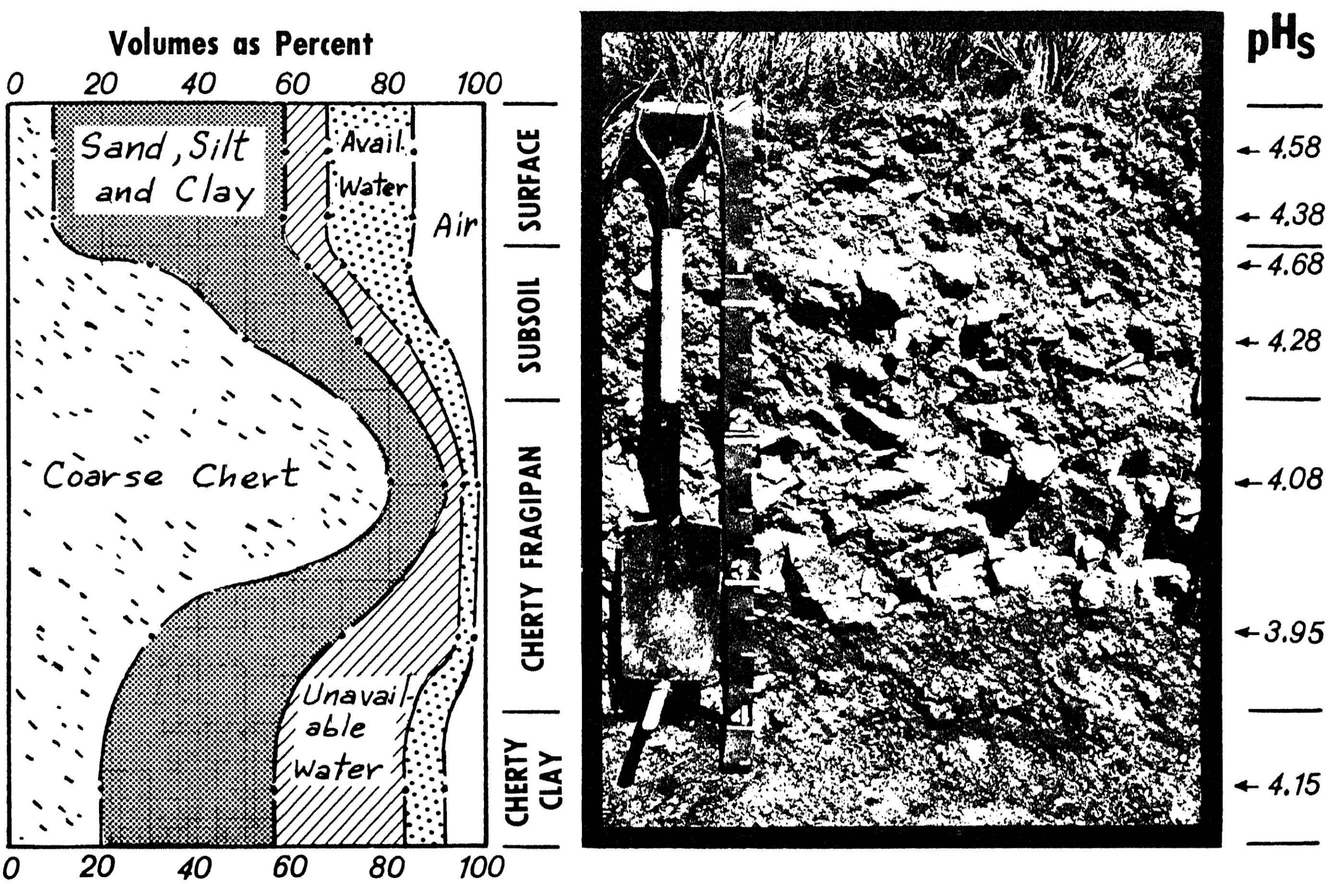
Available water storage capacity is 4.8 inches of water in 3 feet of soil and 5.5 inches of water in 4 feet of soil. These low capacities result in early drought damage to crops during periods of rainfall shortage.

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

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, Missouri, 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 seedling and a fescue hay crop will be 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 is developing. Also some evidence of saprophytic fungi have 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 (fourth growing season) 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, 7 were noted to have moldy roots when planted.

Some corrective work may be needed to develop central leaders in trees deformed by insect, disease or frost damage but many deformed trees are beginning to straighten and develop straight stems naturally. Hay crops will continue to be harvested from the area to determine production trends as the walnut assumes a more dominant position.

BERMUDAGRASS - LEGUME MANAGEMENT

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Abstract: An experiment to compare productivity of Bermudagrass in pure stand at 3 levels of nitrogen and with alfalfa, red clover, and Ladino clover has shown after 2 years of study that (1) Bermudagrass responded to increasing levels of nitrogen, (2) Bermudagrass + 200# N/A, alfalfa alone and in mixture with Bermudagrass were the most productive of all entries in 1977, and (3) alfalfa showed little response to nitrogen. Bermudagrass contributed very little to total yield in mixture with red clover and alfalfa.

The experiment was established from seed and sprigs (Midland Bermudagrass) on May 9, 1975. Seeding rates used were 10 pounds per acre of Cody alfalfa and Kenstar red clover and 2 pounds per acre of Merit Ladino clover. Sprigs of Midland Bermudagrass were spaced approximately 18 inches apart in two 2-foot spaced rows through the middle of the 10' x 20' plots. Plots were replicated 4 times.

Entries consisted of Bermudagrass at 3 levels of nitrogen fertility (0, 100, and 200 pounds per acre); Ladino clover, alfalfa, and red clover with and without Bermudagrass; and alfalfa with 50 pounds nitrogen per year. Prior to establishment, 0 + 40 + 80 pounds of fertilizer per acre were applied as plowdown to bring soil fertility up to soil test . During 1976 nitrogen was applied to the Bermudagrass in split applications on May 28 and July 9. Nitrogen on alfalfa was applied also on May 28. All plots were fertilized with 0 + 60 + 252 pounds of fertilizer per acre on August 18. During 1977 nitrogen was applied to alfalfa-nitrogen plots on March 25 and to Bermudagrass-nitrogen plots in split application on May 13 and June 27. All plots were fertilized with 0 + 60 + 252 pounds of fertilizer per acre on August 16.

Yields in 1976 and 1977 are shown in Table 1.

Entry	%		Tons DM/A		
	Legume	Grass	1976	1977	Aver.
Bermudagrass + 100# N/A		99	2.44	3.88	3.16
Bermudagrass		84	.75	.95	.85
Bermudagrass + 200# N/A		100	3.60	6.06	4.83
Bermudagrass + alfalfa	88	12	6.62	6.52	6.57
Bermudagrass + red clover	83	17	6.96	6.45	6.70
Bermudagrass + Ladino clover	52	44	3.93	4.66	4.30
Alfalfa	100		6.17	6.08	6.12
Red clover	99		6.84	5.20	6.02
Ladino clover	98		3.43	1.82	2.62
Alfalfa + 50# N/A	100		6.50	6.05	6.28

PINES UNDER STUDY AT SOUTHWEST CENTER

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Abstract: Survival, growth, foliage characteristics, and other traits of planted pines are strongly associated with site conditions under which parental stocks evolved. This is being borne out at Southwest Center through extensive seed-origin studies of Scotch and ponderosa pines, two wide-ranging species in nature. In more limited studies, pinyon pine plantings from three geographic origins have almost completely failed, and a New Mexico source of southwestern white pine shows promise. A unique cover in Southwest Missouri, these pine stands are being used heavily by nesting birds, especially doves.

Scotch Pine Seed-Origin Study

In 1961 a Scotch pine (*Pinus sylvestris* L.) seed origin study was established at Southwest Center as a part of a broad test in the North Central Region. Progress and results of this experiment, mostly in terms of Christmas tree production, have been reported annually since 1965. An experimental design using 72 origins and 5 randomized blocks permitted routine statistical analyses. Briefly, it can be stated that a wide diversity of genetic differences is associated with the geographic origins of the seed from which nursery stock of the species is commercially produced.

It should be explained that Scotch pine has the most extensive natural occurrence of any of the world's approximately ninety-five pine species. Its native range almost spans the Eurasian land mass, extending from Scotland almost to the Pacific Ocean. Latitudinally, it spreads from Scandinavia southward into the mountains of Spain, Italy, Greece, Turkey and the Bible lands. It is not surprising, therefore, that this pine is one of the most racially differentiated of forest tree species.

When trees derived from various provenances are compared, great contrasts are found. Among the most striking differences are the following:

a. Initial survival of planted trees ranged by geographic origin of the seed from 100 to below 10 percent.

b. Fastest growing sources are more than four times the size of the slowest.

c. Needle length by source ranges from slightly over one inch to almost four inches.

d. Winter needle color ranges from lemon yellow to good shades of green.

e. Differences in pollination dates are so great that some sources are reproductively isolated from each other, even though growing together on a common area. Biologically, therefore, they are no longer effectively of the same species. Any crossing of such origins must be artificially accomplished.

There is also great variation in certain traits among trees within the different sources. Best genetic gains require an intensive selection, utilizing the best trees in each of the promising origins, followed by breeding.

There is a surprising consistency of interstate results. For example, fast-growing or good-color performers in Missouri give similar results in Michigan, etc. Said another way, there is less genetic x site interaction than was anticipated.

Best sources for Christmas tree purposes are mostly from various provinces in the more southerly range of Scotch pine, i.e., from localities in France, Spain, Greece, Turkey and southern Russia west of the Caspian Sea. It has been further learned, however, that Spanish sources and certain French origins are highly susceptible to a serious needlecast disease and should be avoided.

One of the primary points of interest in this study of Scotch pine is the natural expression of crown characteristics. It is therefore desirable to maintain an openly stocked stand, minimizing competition between adjacent tree crowns. By the end of the 1967 growing season (7 seasons after the planting of 2-0 seedlings at a 7 X 7-ft. spacing) much crown closure had taken place. The stand was thinned in February, 1968, removing 275 trees. The number of trees in the residual stand is 530.

Work with these Scotch pine origins is now moving into a breeding phase. Trees are being selected from various points in Missouri, including Southwest Center, and adjacent states. Scions have been taken from the selected trees to produce a breeding orchard of graft clones. It seems obvious that superior varieties for Christmas trees and perhaps other purposes can be developed from this genetically diversified species. Less certain, however, is whether or not seed orchards of Scotch pine will be sufficiently productive of seed under Missouri conditions. This question is necessitating a study of factors affecting seed production in Scotch and other pines.

Ponderosa Pine Provenance Study

In April, 1968, a planting of ponderosa pine (*Pinus ponderosa* Laws.) was carried out at Southwest Center to test the effects that geographic source of seed can have on the performance of this species. With minor exceptions that involve several of the total of 79 seed origins, the general experimental plan uses eight replicates of 4-tree plots in a completely randomized main block, plus two more replicates per origin in a border around the main block. A few additional plots of some origins were required to fill out the rectangular plantation of 58 rows and 56 columns, giving a total of 3248 trees planted.

This is part of a broad interstate study of ponderosa pine in the North Central Region. Nursery stock for two Missouri tests (a similar planting has been made in Boone County near Columbia) came from the U.S. Forest Service nursery at Halsey, Nebraska.

Despite the use of hardy 2-1 stock, this planting in southwestern Missouri is expected to provide a severe test of initial survival abilities for the different origins. Any drouth conditions will be accentuated by the very stony Baxter soil and the exposure of the site to hot, dry winds from the south and west.

By far the most important pine of western North America, this species is widely distributed in the mountainous West. Indigenous to the Rocky Mountains and mountain ranges of the Pacific coast, it spans a territory from North Dakota, Montana, and British Columbia in the north to southern California, Arizona, New Mexico, and Trans-Pecos Texas. At the eastern edge of its range, ponderosa pine is found in many disjunct occurrences -- including northwestern Oklahoma, parts of Colorado, and western Nebraska. It blankets the Black Hills of South Dakota, giving the hills their dark appearance when viewed from the plains.

As with Scotch pine, it is not surprising that this widespread species gives abundant evidence of genetic diversity. A complex of geographic races has been variously recognized, but such races are usually difficult to delineate because they intergrade. Seed collections for the present study were planned to test broadly dryland origins of the species on both a geographic and local basis. To provide a check with material from elsewhere in the natural range of ponderosa pine, the total list of 79 origins includes several collections from coastal mountain ranges in Washington, Oregon, and California.

Past plantings of ponderosa pine in Missouri have given variable results. Excellent trees of the species are occasionally found in plantations, windbreaks, and as ornamentals. Too frequently, however, the species is severely attacked by the Dothistroma needlecast disease, resulting in heavy mortality, loss of growth, and general degradation of the stands.

These nursery stocks from such diversified seed origins promise to provide the best background of information yet obtained for an intelligent use of ponderosa pine in Missouri, elsewhere in the Midwest, and in the Great Plains. Associated with origin of seed, differences have been obtained in survival, hardiness, quantitative and qualitative growth factors, crown characteristics, and pest resistance. With reference to disease, it is already known that some ponderosa pines have a high resistance and perhaps even an immunity to the serious Dothistroma needlecast referred to above. Such differences in disease susceptibility are associated with geographic or local races within the species. Some considerable depiction of this host-pathogen relationship is a prospect of the present study.

Inherent differences of the magnitude and kinds expected for ponderosa pine have been observed already in the 3-year-old nursery stock. Seedlings of some origins were several times larger than others. Needle lengths ranged from three inches to over six inches, foliage color from pale gray-green to a bright green. Also observed were marked variations in needle stoutness and straightness.

Differences noted at the seedling stage are becoming ever more apparent as the stand develops. The trees were measured in September, 1975, after eight growing seasons in the field. Associated with natural origin of seed, mean tree heights at that date ranged from 8.96 feet down to 4.79 feet, with individual tree heights ranging from 12.0 feet to 1.7 feet. There is no obvious regional pattern in these height differences. Rather, there is considerable variation within regions, suggesting the possibility of strong local racial differentiation. The tallest mean heights are being obtained from seed collections in New Mexico and Nebraska and the shortest from Colorado and Wyoming, but there is a considerable range in height performance between seed origins obtained within these states.

Pinyon Pine

Three seedlots of pinyon pine (*Pinus edulis* Engelm.) were collected in the vicinities of Meeker, Colorado; Flagstaff, Arizona; and Young, Arizona. Stock of hardy appearance was produced from all three sources on a deep loess at Elsberry, Missouri, but poor results from field tests have been obtained in northwestern, central, and southwestern Missouri. A plot of 31 seedlings 3 years old was planted at Southwest Center in 1961. Initial survival was not good, and subsequent mortality has further reduced the plot to only five living trees. These are scrubby, around 5 feet tall. Results here and at other test sites suggest that *Pinus edulis* requires better soil aeration than is obtained on most Missouri uplands.

Southwestern White Pine

Sixty seedlings of Southwestern white pine (*Pinus strobiformis* Engelm.) were planted at Southwest Center in 1961. This stock was produced from seed collected in the mountain foothills (el. 7600 feet) between Alamogordo and Cloudcroft, New Mexico. In addition to being a test of adaptability to the site, this plot compared 3-0 bare-root vs. 2-1 potted stock (30 seedlings each) as establishment methods. Results have produced no significant difference associated with kind of planting stock. Despite one killback of the new flush of annual growth by a late freeze in May, a moderately good development has been made. The trees are straight, symmetrical, and of a yearlong dark green color. Problems have been (1) occasionally severe browse and antler damage by deer, especially at the plot border, and (2) defoliation of some trees by the bagworm (*Thyridopteryx ephemeraeformis* Haw.). The attack by this insect killed or severely damaged most of the trees before discovery of the problem.

EVALUATING FLORIDA ZOYSIAS FOR USE IN MISSOURI

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Abstract: Zoysia grass is an alternative to cool season grass for use as turf in central and southern Missouri. We have been studying 60 entries from Florida since 1971 for characteristics indicating adaptation to the transition environment of our state. Among several promising entries, six have shown excellent winter hardiness in Columbia. We will be concentrating on this group for continued evaluation and possible joint release with the University of Florida.

Much of Missouri is included in a "transition zone" where neither cool nor warm season grasses are completely adapted. This makes the culture of turf difficult, especially in the southern half of the state. An approach to this problem is breeding of tall fescue and other cool-season grass varieties which are better adapted to Missouri summers. An alternative approach is the culture of warm season grasses like zoysia.

Zoysia makes it's best growth when temperatures are near 100^{o}F and is well adapted to long summers and mild winters of the southern United States. Heat and drought tolerance is excellent although it responds well where irrigation is available. Tolerance to mowing as low as one-half inch makes zoysia popular for use on close-mowed fairways and tees of golf courses as well as lawns. Once established it forms a dense, tight turf which requires minimal weed control when the grass is actively growing in summer.

Disadvantages associated with the use of zoysia include a long period of dormancy which lasts from 6 to 7 months in Missouri. Many people consider the brown color objectionable over such a long interval. Injury and occasional loss of some zoysia species may occur during severe winters. Dense growth of zoysia turf contributes to thatch buildup and without proper management this may impede movement of water, air and nutrients into the soil causing a decline in the quality of the turf.

At the present time, use of zoysia in Missouri is mostly limited to the variety Meyer. Other zoysia entries at the Southwest Center include the varieties Midwest, Emerald and about 60 experimental selections from Florida, mostly, of the species Matrella. Field plots of zoysia were established at the Southwest Center by sprigging in late June, 1971. They are mowed to 1 inch about every 2 weeks with a rotary mower and irrigated as needed. Fertilizer, usually in the form of ammonium nitrate, is applied to the area at a rate of 1 to 2 lbN/1000 sq. ft./yr. Phosphorus and potassium are kept at moderate to high levels according to soil test.

Several of the entries have consistently shown desirable turf characteristics over a 6-year period as indicated by selected ratings in Table 1. Six entries have also shown excellent winter tolerance based upon our observations of test plots in Columbia. (see underlined entries) We will be concentrating on this group during the next few years by establishing replicated tests in selected areas of Missouri and other states located in the upper South. Possible joint release of one or more varieties in cooperation with University of Florida is contemplated for future years.

Table 1. Selected ratings for Florida zoysia selections, 1974 to 1977, Southwest Center

Entry	% Cover 8/15/74	Drought Tolerance 8/12/75	% Green 5/26/77	Quality 7/19/77	Green 10/21/77
C5	85	4.0	25	2	8
A5	5	1.0	-	2	-
B8	80	5.0	20	5	6
C6	5	1.0	-	2	-
C9	5	1.0	60	6	7
D10	-	1.5	60	5	7
A7	3	1.0	-	1	-
D14	85	7.5	60	6	8
A14	100	7.0	70	6	4
B9	10	1.0	60	5	5
C12	1	1.0	-	2	-
C8	60	6.5	60	6	7
D16	20	3.0	100	4	4
D7	90	5.5	60	5	8
C1	80	4.0	30	7	5
A13	10	1.5	-	2	-
B4	-	1.0	-	2	-
D4	60	4.5	50	6	5
A9	100	5.5	60	7	7
A4	5	1.0	-	3	7
C13	-	1.0	-	1	-
A6	-	1.0	50	4	4
B15	90	5.0	50	6	7
A3	100	8.0	70	7	8
B13	85	5.5	60	5	4
A1	100	5.0	90	5	5

Entry	% Cover 8/15/74	Drought Tolerance 8/12/75	% Green 5/26/77	Quality 7/19/77	Green 10/21/77
C2	35	3.0	50	5	8
B2	100	5.5	50	6	7
C7	90	6.5	70	6	7
D9	1	1.0	50	6	7
A16	50	4.5	15	3	8
C10	60	5.0	50	5	8
A15	100	5.5	50	5	8
D12	50	4.0	50	6	7
B14	100	5.5	85	6	6
D13	100	5.5	60	6	7
B12	85	7.0	85	7	7
C15	85	1.5	-	3	-
B10	65	5.5	50	6	7
D8	75	4.5	50	5	8
A11	100	5.5	60	5	7
A8	60	5.0	75	4	5
C3	45	3.5	30	5	4
B5	35	3.0	15	3	-
B7	5	1.0	0	1	-
A10	80	7.0	95	8	6
C4	1	1.0	-	1	-
D11	5	1.0	-	4	4
A2	25	2.0	50	4	6
B3	100	5.5	50	5	7
B16	95	5.0	40	6	5
D6	95	4.5	50	4	4

Entry	% Cover 8/15/74	Drought Tolerance 8/12/75	% Green 5/26/77	Quality 7/19/77	Green 10/21/77
D3	-	1.0	10	2	-
D2	15	1.0	20	1	-
B1	10	1.0	-	3	-
B6	100	4.5	60	5	6
A12	80	5.5	70	6	7
C14	-	1.0	-	2	-
C14	5	1.0	-	2	-
C16	75	4.5	50	5	7
D5	90	3.0	80	4	3
C11	5	2.5	30	6	4
A13	60	4.0	50	5	5
B11	100	5.5	60	6	6
B15	25	4.5	-	6	6

Notes: Where no data is given, entries were usually overrun with weeds; rating, except %, is based on a scale of 1 = poorest to 9 = best; underlined entries are winter hardy in central Missouri.

PERFORMANCE OF YEARLING BEEF HEIFERS ON FOUR VARIETIES OF FESCUE HAY

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Abstract: Thirty-two replacement heifers were fed for 70 days on a diet of 55% fescue hay and 45% grain. The fescue hay was of four varieties: Kentucky 31, Kenhy, Kenmont, and Missouri 96. Heifers fed the Kenmont hay gained significantly less than heifers on the other three groups. Average daily gain was 2.39, 2.21, 2.06, and 1.93 pounds for Missouri 96, Kenhy, Kentucky 31, and Kenmont, respectively.

INTRODUCTION

Fescue is an important part of the forage-livestock industry in South Missouri. Fescue has also been an important part of the research effort at Southwest Center. Results of grazing trials at the center have indicated that cattle on Missouri 96 and Kenhy fescue pastures gained better than on Kentucky 31. The objective of this trial was to estimate differences in performance on four varieties of fescue hay.

PROCEDURE

Thirty-two replacement heifers were fed for 70 days on a ration composed primarily of fescue hay (Table 1). The diet was designed to give approximately 1.5 pounds of gain per day. Four varieties of fescue hay used were Kentucky 31, Missouri 96, Kenmont, and Kenhy. The hay was grown on the Southwest Center at Mt. Vernon and transported to Columbia for feeding at the UMC Beef Cattle Farm. The hay was cut at the proper time to insure good quality. The first cutting was May 10-15 and the second in early July. The plots had been fertilized in the spring with 75-50-50. The four varieties were very similar in composition (Table 2). Angus and Simmental heifers raised on South Farm (approximately 10 months old) and Hereford heifers from the Forage Systems Research Center (approximately 15 months) were used in the feeding trial. Heifers were allocated by weight and height as well as a uniform distribution by breed. The heifers were fed in pens of four animals. Each of the four treatment groups was made up of two pens (replicates). Feeding was ad lib. Initial and final weights were taken after the heifers had been off feed and water for 12 hours.

RESULTS

Initial weights, final weights, and average daily gain (ADG) by pen are shown in Table 3. The ADG by treatment was 2.39, 2.21, 2.06, and 1.93 pounds for Missouri 96, Kenhy, Kentucky 31, and Kenmont, respectively. The gain of heifers on Missouri 96 and Kenhy was significantly greater than heifers on Kenmont. The heifers on Kentucky 31 did not differ significantly from any other group in ADG. One heifer in Rep 1 of the Kentucky 31 treatment group exhibited signs of estrus at the end of the trial and had a larger than normal shrink prior to weighing off test. The average gain of that group could have been closer to the Kenhy group. Rep 1 was composed of the heavier half of the heifers and Rep 2 of the lighter heifers. The ADG for Rep 1 was 2.06 and for Rep 2 was 2.24 pounds.

This demonstration project indicates that cattle fed fescue hay of different varieties and of similar nutritional composition may have different gains.

Table 1. Ration composition

Fescue hay (ground)	55.15%
Cracked corn	25.78%
Crimped oats	14.99%
Molasses	4.08%

Table 2. Hay composition (percentages)

	Kenhy	Kentucky 31	Kenmont	Missouri 96
Dry matter	87.6	86.6	87.5	87.6
Crude fat	2.1	2.0	2.0	2.2
Crude fiber	33.3	33.4	33.7	32.6
Ash	5.7	6.5	7.2	6.2
Protein	10.9	10.9	12.0	11.6
ADF	34.7	34.4	33.3	32.4
NDF	65.5	63.9	63.5	63.2
K	2.12	2.46	2.49	2.38
P	0.24	0.28	0.30	0.28
Ca	0.26	0.26	0.39	0.28
Mg	0.20	0.21	0.23	0.23

Table 3. Means[1] for animal performance (pounds)

	Initial Weight	Final Weight	Gain	ADG
Missouri 96				
Rep 1	553	705	152	2.18
Rep 2	455	638	183	2.61
Average	504	672	168	2.39[b]
Kenhy				
Rep 1	558	714	156	2.22
Rep 2	482	636	154	2.21
Average	520	675	155	2.21[b]
Kentucky 31				
Rep 1	568	700	132	1.89
Rep 2	459	615	156	2.23
Average	514	658	144	2.06[ab]
Kenmont				
Rep 1	559	696	137	1.97
Rep 2	492	625	133	1.90
Average	526	660	135	1.93[a]

[1]Means with the same letter are not significantly different (P<.01).

SOUTHWEST CENTER SWINE EVALUATION STATION

by
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In 1978, 510 boars were tested through the facility at the Southwest Center Swine Evaluation Station. Since the establishment of the swine test station, 786 boars have been evaluated.

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 1978 were held on January 21, February 18, July 21, and August 17. 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 lioneye area. The average performance and range for each trait for the 786 boars that have been on test are included in the following table:

Boar Data for Southwest Center Swine Evaluation Station
(1975-1978)

Trait	Average	Range
Av daily gain (lbs)	2.01	1.40-2.68
Feed/lb gain (lb)	2.66	2.21-3.18
Backfat (in)	.77	.60-1.07
Loineye area (sq in)	5.75	5.00-6.86

There have been fifteen performance tested sales held since the test station was built. Five-hundred ten boars have been sold for a total of $151,991, for an average of

$298 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 $700 per boar. All costs of the test are paid by the breeders.

In addition to the individual data on boars, a pen index system has been used this year. 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.

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.

1977-78 Fescue Toxicity Studies

Drs. Geo. B. Garner, Creighton Cornell, Biochemistry Dept.-UMC, Mr. Stan Bell, Southwest Center, Mr. Shelly Yates, Northern Regional Res. Laboratory, USDA, Peoria, Illinois, and Dr. C. W. Bacon, Russell Agriculture Res. Center, Athens, GA

Abstract: In a winter grazing trial with steers on fall regrowth, the relative ranking of 5 varieties of tall fescue with respect to fescue foot symptoms was Ky-31, Kenhy, Mo-96, Kenmont and Fawn. Interperitoneal infusion assay of extracts from Ky-31 and Mo-96 hay also demonstrated that the toxin was present in both. Average daily gain of steers grazing the experimental pasture in Jan-Feb. was Mo-96, 0.667 lbs/day, Kenhy, 0.55, Kenmont, 0.43, Fawn, 0.377 and Ky-31, 0.347. A study of Epichloe typhina (a fungus) presence in the grass failed to show correlation with symptoms of fescue foot in grazing steers. The use of thermo-vision as an objective means of measuring animal response to the fescue foot toxin was continued using extracts from hay grown at the Southwest Center.

To determine the relative toxicity (fescue foot potential) of five tall fescue varieties, one acre pastures in the Northwest corner of the Center were treated as follows. In early spring, 1977 maintenance fertilizer was applied (75-50-50). Hay was cut on May 10-15th and again in early July. The stubble was fertilized with 150 lbs N as ammonium nitrate in August. Ample rains and a good fall growing season supported a growth of nearly 2 tons D.M./Acre. Varietal yield differences were small. In December 1977, a diagonal strip was cut across each pasture with a forage chopper. Grass from the three reps of each variety harvested was combined, wagon dried, sacked, weighed and shipped to either UMC-Columbia or to USDA's Northern Regional Research Lab., Peoria, IL. Ky-31 and Mo-96 samples were extracted at Peoria and the processed extracts used in an infusion trial to be described later in this report.

The remaining grass was left in the pastures for a grazing trial which began Jan. 4th, 1978. Sixty head of steers were purchased from 2 area cattlemen at the end of November, 1977. These steers were acclimated and observed during December. They were fed free choice orchard grass hay and a salt limited grain supplement. The steers were shrunk on Jan. 3rd, weighed on Jan. 4th and allotted to pastures based on weight of animals and source of supply. There were four animals per pasture. Animals were observed on pasture, individually, on 32 different days and evaluated twice (March 1 and April 6th) in the chute for coronary band lesions, tail necrosis and lameness.

The steers had free choice mineral but no supplement was fed in the trial except hay of the same variety when snow storms occurred. Each animal was offered 76 lbs of hay total during the 55 day trial, 40 days of which there was snow cover. Because of the difference in grass available, weight measurements were not reported during the March 1- Apr. 6th period but observations for fescue foot were continued. Only one animal (a Ky-31 steer) became so crippled that he was removed just prior to the March 1st weigh day.

Results

To give a numerical rating for severity of fescue foot symptoms,the following table was used:

Evaluation of Relative Severity

of Fescue Foot Symptoms

Points	Symptoms
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 lesions on both feet

The relative ranking of the 5 varieties is based on the sum of severity for 32 days of pasture observations and 2 careful examinations in a chute. In table II, Score 1 gives the relative severity for tall fescue varieties based on 32 observations. Score 2 is based on examinations in-chute on March 1 and April 6th.

Summary of Relative Severity of Fescue Foot Symptoms in Beef

Steers Grazing 5 Varieties of Tall Fescue From

Jan. 4 - Apr. 6, 1978

Variety	Score #1	Score #2	Total	Ranking
Ky-31	205	54	259	1
Kenhy	193	49	242	2
Mo-96	121	36	157	3
Kenmont	70	46	116	4
Fawn	19	30	49	5

Table III gives the average daily gain for the first 55 days of the trial.

Fifty-Five Day Average Daily Gain of Beef Steers Grazing 5 Varieties of Tall Fescue From Jan. 4 - March 1, 1978

Variety	Rep 1	Rep 2	Rep 3	Mean
Ky-31	0.35	0.47	0.22	0.347[a]
Fawn	0.38	0.39	0.36	0.377[a]
Kenmont	0.38	0.49	0.42	0.430[ab]
Kenhy	0.72	0.59	0.34	0.550[bc]
Mo-96	0.75	0.63	0.62	0.667[c]

[a,b,c]Means with different superscripts differ significantly ($P<.05$).

Each variety- 3 pastures with 4 steers each (660 animal days/variety).

When one compares Ky-31 and Fawn in this trial, we find equal animal daily gain but the greatest difference in severity of fescue foot. Thus the toxin itself is not necessarily responsible for low gains. Until the severity of the symptoms become great enough to limit the animals mobility and consequently its food intake there is probably little connection. However, when we consider the better animal gains on Mo-96 and Kenhy there does appear to be a more direct cause and effect. When one takes into account other comparisons of gains between Mo-96 and Kenhy these difference are in line with expected results for non-fescue foot seasons of the year. Therefore the toxin does not necessarily affect gain.

We (Geo. B. Garner, C. N. Cornell) would point out that animals fed ground corn (1-2#/head/day) on toxic tall fescue have less symptoms and less weight loss than controls. Thus one can speculate that because they support better animal gains, Mo-96 and Kenhy could even contain a greater amount of toxin than Ky-31. Once we identify the chemical component that is responsible for the toxicity we can then answer this question.

In the Intraperitoneal Infusion Assay, at Columbia, we found Mo-96 bottom anion fraction to be more toxic than Ky-31 bottom anion fraction as measured by both visual observations and thermovision. We had previously found a Kenhy extract from hay grown in Kentucky to be more toxic than the Ky-31 extracts tested at that time. This would support the above arguments. We have now completed three years of thermovision work with good results. Thermovision indicates a temperature drop in the region of the coronary band before visual symptoms appear and it is more objective than visual measurements. This research tool will also be valuable in studies of dose rate and evaluation of treatments to relieve or eliminate fescue foot in an animal. The I.P. Assay plus thermovision is now a useful tool in evaluating as little as 200 lbs of D.M. of a new fescue variety for fescue foot potential.

Epichloe typhina (a fungus) had been found in toxic fescue samples from several states. In Dec. 1977, sod plugs taken by Stan Bell from each pasture were wrapped in a paper towel, packed and sent to Dr. Charles Bacon, mycologist, Athens, GA, for evaluation. His findings are presented in table (IV).

Table IV. Frequency of Epichloe typhina in fescue sod plugs, Dec. 1977.

Variety	Pasture Number	Frequency % $\frac{\text{No. Infected Tillers}}{\text{Total Number Tillers}} \times 100$
Ky-31	2, 11, 16	92, 85, 93
Kenhy	5, 10, 13	0, 17, 16
Kenmont	4, 8, 17	2, 4, 9
Fawn	3, 9, 15	0, 0, 0
Mo-96	2, 12, 14	0.89, 0.35, 0

In May 1978, Dr. Bacon came* to Mt. Vernon and we re-examined the pastures for E. typhina.* The Results are in table (V).

Table V. Frequency of Epichloe typhina in fescue seed stalks, May 10, 1978.

Variety	Pasture Number	$\frac{\text{No. Infected Seed Stalks}}{\text{Total Number Examined}} \times 100$
Ky-31	2, 11, 16	22, 26.6, 50
Kenhy	5, 10, 13	20, 0, 30
Kenmont	4, 8, 17	75, 40, 30
Fawn	3, 9, 15	0, 0, 0
Mo-96	2, 12, 14	0, 0, 0

*Special thanks are due to Dr. Arnold Foudin and Dr. Einar Palm, Plant Pathology, for their help in the May evaluation.

From this data, we see no correlation between the presence of *E. typhina* and the occurence of fescue foot symptoms in grazing cattle. We do see varietal differences with respect to the presence of the fungus.

Our work will continue for the 1978-1979 fall-winter period very much like last year's study. We have increased our nitrogen application to 200 lbs N/A (Aug. appl.) and will harvest for extraction in Dec. The remainder will be grazed in Jan-Feb. The grazing period length will be dependent on the amount of fall regrowth. A similar study at Columbia is expected to be carried out the following year.

STORAGE and FEEDING LOSSES of LARGE ROLL BALES

Stored Inside vs. Outside a Barn

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Abstract: Six large roll orchardgrass-legume hay bales stored inside a barn lost 2.1 percent dry matter during 8 months storage compared to 17.0 and 18.8 percent for 10 bales stored outside on poles, and 7 bales stored outside on the ground, respectively. The bales stored outside on poles, and outside on the ground had 5.1 and 7.8 percent, respectively, greater feeding waste inside a circular feeder than barn stored bales when fed to 38 bred Holstein heifers. More of the barn stored hay was pulled out of the feeders than the outside stored hay resulting in equal feeding losses. Unrolling eight bales averaged 31.6 percent waste which was 16.7 percent greater than the 14.9 percent average for 15 bales fed in circular feeders. Three orchardgrass large roll bales stored outside two years averaged 25.5% dry matter storage loss which was 11.3% greater than after the first year of storage.

Introduction:

Previous studies here have measured storage and feeding losses from large roll bales stored outside on the ground or elevated about six inches on poles. The primary purposes of this study were to measure storage and feeding losses on barn-stored vs. outside-stored large roll bales, and individually stored vs. bales butted end to end in storage.

Procedure:

Orchardgrass, ladino, and red clover mixed hay was cut May 23, 1977, and rolled into large bales with a New Holland, Model 850, baler on May 26, 1977. The hay was 65% orchardgrass and 35% legume with 12.6% protein and 61.8% InVitro dry matter digestability.

The bales were weighed out of the field between June 3 and June 9; sampled to determine moisture content; and randomly placed in storage either inside a barn or outside. Six bales were stored inside a barn on straw bales to prevent moisture absorption into the bottom of the bales from the dirt floor. Of the twenty bales stored outside, ten were stored on telephone poles and butted end to end; three were stored individually on poles; and seven were stored individually on the ground.

The bales outside received 36 inches of rain between baling and feeding. The bales were fed between January 27, 1978, and March 22, 1978, to 38 head of bred Holstein heifers weighing 885 pounds. Square bales (primarily oat hay) were fed on weekends and during severe weather.

Results and Discussion:

Storage dry matter losses ranged from 2.1 percent to 18.8 percent for large roll bales stored inside and outside on the ground respectively. Table 1 summarizes dry matter storage losses.

Table 1. Dry Matter Storage Losses for Barn Stored and Outside Stored Large Roll Bales.

Type of Storage	Number of bales %	Dry Matter Storage Loss %	Range of Dry Matter Storage Loss %
Barn	6	2.1	1.1 to 3.0
Outside, individually on the ground	7	18.8	15.9 to 25.6
Outside, individually on poles	3	18.5	13.2 to 20.5
Outside, butted end to end on poles	10	17.0	13.6 to 22.4
Outside, individually two years storage	3	25.5	23.7 to 28.0

The 2.1 percent storage loss for bales stored in the barn is low because the bales cured to 93.6% dry matter in the field before being weighed and stored. The bales stored outside cured the same amount of time in the field so the storage losses outside may also be low. Bales stored on poles and butted end to end lost about 2 percent less dry matter than bales stored on the ground or bales stored individually on poles.

Outside dry matter storage losses in this study on orchardgrass-legume hay were about 4 percent greater than on straight orchardgrass hay baled in 1976. Rain and moisture penetrated the orchardgrass-legume hay from 8 to 14 inches causing mold and discoloration. Orchardgrass hay baled the previous year with the same baler had only 4 to 6 inches spoilage. Moisture penetrated further into the bales toward the looser ends of the bales than into the tighter middle of the bales. The large amount of spoilage could be due to the unusually long periods of wet weather during the fall of 1977, the type of hay in the bales, or the type of baler used.

Four orchardgrass bales were held over for a second year. In 1977, after one year storage, ten bales had an average of 14.2% dry matter storage loss. In 1978, after two years storage, three bales averaged 25.5 percent dry matter storage loss, or an additional 11.3 percent loss the second year of storage. One bale not included in the average because of severe wind damage had a total of 52.8 percent storage loss.

Feeding losses by unrolling the bales, compared to using feeders, seemed large in 1977. Therefore, the bales were fed by either unrolling one-days feed or by using two circular feeders. The hay was fed to one group of 38 bred Holstein heifers because this was the maximum number of heifers that could eat around two circular feeders.

Feeding losses and intake are summarized in Table 2.

Table 2. Dry Matter Hay Waste and Intake for Bales Fed in Circular Feeders or Unrolled on Pasture for Various Storage Methods.

	WASTE						DRY MATTER HAY INTAKE	
		Feeders			Unrolling			
Storage Method	Number of bales	Inside %	Outside %	Total %	Number of bales	Total %	Feeders lbs./head/ day	Unrolling lbs./head/ day
Barn	4	0.2	14.9	15.1	2	26.0	17.4	10.1
Outside, individually, on the ground	4	8.0	7.2	15.2	3	36.4	14.2	10.9
Outside, individually, on poles	2	10.4	14.5	24.9	1	27.4	12.2	10.3
Outside, butted end to end on poles	7	5.3	9.5	14.7	3	31.3	14.5	13.1
Square bales	235	--	--	2.7	--	--	16.9	--
Outside, individually	4	12.3	--	12.3	--	--	12.1	--

Feeding waste when using the feeders is divided into that hay left inside the feeders and that picked up from outside the feeders. Hay left inside the feeders averaged 5 to 8 percent more for bales stored outside than for bales stored inside. The hay wasted was wet, moldy, and discolored. Bales stored outside on the ground had about 3 percent greater waste inside the feeders than those stored outside on poles.

Feeding waste measured outside was quite variable due to weather conditions. In some cases, mud and snow prevented collection of all the hay pulled out of the feeders. Excessive amounts of barn-stored hay were pulled out of the feeders because the bales overfilled the feeder. Barn stored bales did not weather or shrink, therefore, were larger than the bales stored outside. Even the bales stored outside were too large for the feeders during the snowy, wet, and muddy conditions of the winter of 1978. During dry weather, much of the hay that is pulled out of the feeders is eaten.

Four two-year-old bales were fed in feeders and averaged 12.3% refused hay. This was very simular to waste from the same hay fed in 1977. All of the feeding waste measurements are expressed as a percent of the hay fed.

Feeding by unrolling the bales resulted in high feeding waste. Weather caused a wide variation in waste. One barn-stored bale,unrolled on two days in March, had 16.2 percent waste and one outside-stored bale, unrolled on two days of melting snow in February, had 47.5 percent waste. For two consecutive years, feeding losses from unrolling have been 10 to 15% higher than when using a circular feeder. These large feeding wastes from unrolling resulted dispite limited feeding which reduced hay intake by over 30 percent.

Feeding oat hay in square bales resulted in small hay waste and intake was very near to that of the barn-stored large bales. All heifers received 5 pounds of a 12% dairy ration per day. Total dry matter hay and grain intake of about 21.5 pounds for square bales was about 2.5% of body weight, which is near normal for the heifers used in this study. However, the reduced intake on bales stored outside limited average daily gain to 0.95 pounds per day over a 42-day period from 1-31-78 to 3-14-78.

This study shows a need to consider barn storage of orchardgrass-legume hay for feeding and growing replacement dairy heifers. Unrolling leafy legume hay wastes good hay, reduces intake, and slows growth of heifers. Further research needs to be done for various grass and legume hays to determine storage needs.