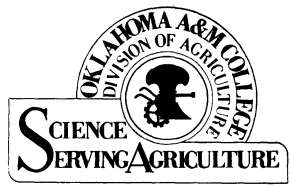
A Feed Crop Rotation For Central and Eastern Oklahoma

By

Fenton Gray and Horace J. Harper



EXPERIMENT STATION

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Here's the Rotation, and What It Will Do.

A suggested feed crop rotation for central and eastern Oklahoma, based on the results reported in this bulletin, is as follows:

First Year: Spring oats in 14-inch rows, overseeded with biennial sweet clover.

Second Year: Second-year sweet clover, followed by rye sown about September 15 for winter pasture.

Third Year: Sudan grass for pasture or hay.

Fourth Year: Sorghum for silage.

This rotation will produce about 3 times as much protein as the same acreage in good prairie hay. And it will do a satisfactory job of controlling erosion on sloping land.

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By

Fenton Gray and Horace J. Harper*

A crop rotation which will produce protein for livestock feed and at the same time maintain soil fertility and control erosion is needed on the smaller farms in central and eastern Oklahoma. A rotation designed to meet this need was tested from 1941 through 1954 on the Experiment Station's Perkins Farm, nine miles south of Stillwater. This bulletin reports the results.

Any crop rotation plan designed for this area must take account of the following conditions:

- An adequate supply of protein feed is important in successful livestock production; and the cost of protein is normally less when grown on the farm where it is fed.
- Crops harvested for hay or silage remove more soil fertility than do grain or cotton. Therefore careful fertilization is important in managing a forage crop rotation.
- Grass can control erosion; but without legumes it does not produce enough protein per acre to support livestock production on smaller farms.
- Biennial sweet clover is one of the best crops for adding nitrogen to the soil in central and eastern Oklahoma.

The Rotation Plan

CROPS GROWN

The crops used in the rotation were:

1941 - 1947

First Year: Kanota spring oats in 14-inch rows, interseeded with Evergreen sweet clover.

Second Year: Second-year sweet clover.

Third Year: Sudan grass.

Fourth Year: Atlas sorghum.

* Respectively: associate professor, Agronomy; and, director, Agricultural Division, the Samuel Roberts Noble Foundation and assistant director, Oklahoma Agricultural Experiment Station.

1948 - 1954

During the last 6 years of the test, Abruzzi rye was sown in the fall following the second-year sweet clover. Rye was used to provide pasture and a cover for the land during winter months.

Yields from this rotation were compared with yields from an adjacent plot planted to Sudan grass each year and another plot planted to Atlas sorghum each year. Two adjacent plots were maintained in prairie hay. Yields from the rotation and those from the continuous growing crops were compared. Starting in 1948, rye was planted following continuous Sudan to provide cover during winter and to determine the amount of rye pasture that could be produced.

METHODS OF PLANTING

Oats were planted during the latter part of February in 14-inch rows at the rate of 1½ bushels of seed per acre. The drill was set to plant 3 bushels per acre, and every other opening in the drill was then closed to get the 1½-bushel rate in 14-inch rows. Rock phosphate was drilled (200 pounds per acre) between the oat rows as described below.

Sweet clover was seeded at the same time as the oats, using a grass seed attachment on the drill to place the seed in the fertilized area between the oat rows. Seeding rate was 8 pounds per acre.

Sudan grass was planted about May 1 at 30 pounds per acre in 7-inch rows.

Sorghum was planted early in May at the rate of 4 to 5 pounds per acre in rows 42 inches apart.

Rye was planted about September 15 where it followed the second-year sweet clover. The clover residues were disked prior to seeding the rye. The seeding rate was 1.5 bushels per acre in 7-inch rows.

SOIL FERTILITY TREATMENTS

The rotation was grown both with and without barnyard manure. On the manured plots, the manure was applied once every four years at a rate equivalent to 80 pounds of nitrogen per acre. It was spread where sorghum had been harvested, and plowed under when preparing seedbed for spring oats.

The soil on which this test was located is a Norge fine sandy loam which is deep, permeable, medium in texture, moderately acid, low in available phosphorus, and moderate in exchangeable potassium. It was limed at the rate of two tons per acre in 1938. The land was high in active organic matter when the test started in 1941, because good crops of sweet clover had been plowed under during the two preceding years.

Rock phosphate was drilled in 14-inch rows with sweet clover at

TABLE I.—Acre Yields of Spring Oats and Sweet Clover in Rotation.

Year	Spring Oats				Sweet Clover (Pounds of dry forage)	
	Manured		Unmanured			
	Grain (bu.)	Straw (lbs.)	Grain (bu.)	Straw (lbs.)	Manured	Unmanured
1941	32.4	2,048	34.7	2,149	----	----
1942	38.5	1,235	30.7	983	8,350	8,045
1943	21.9	1,330	20.7	895	4,600	3,870
1944	49.0	1,365	55.8	1,530	8,955	8,108
1945	31.5	1,625	27.9	1,202	7,745	8,955
1946	58.3	2,253	48.4	1,800	8,107	7,139
1947	54.1	1,623	39.8	974	8,954	7,321
1948	28.8	1,000	28.4	924	6,655	5,263
1949	39.7	1,951	26.6	1,095	9,920	9,015
1950	19.0	1,593	8.8	600	6,050	6,837
1951	13.1	2,040	4.6	1,200	----	----
1952	29.3	1,214	22.8	940	4,598	3,933
1953	18.8	1,600	18.2	1,020	2,904	2,662
1954	34.6	1,480	16.6	660	----	----
Average	33.5	1,597	27.4	1,141	6,128	5,693

the same time the oats and sweet clover were planted, using a fertilizer attachment on the grain drill. The fertilizer attachment was set to apply 400 pounds per acre. Then the pins were pulled in alternate star wheels to prevent fertilizer being applied in the drill rows with the oats. Consequently, only 200 pounds per acre was applied: but, since the fertilizer was concentrated in alternate rows, the rate was 400 pounds per acre in the row where the sweet clover was seeded.

The continuous Sudan and continuous sorghum plots were fertilized every fourth year, with 200 pounds per acre of rock phosphate drilled in 14-inch rows, and manure equivalent to 80 pounds of nitrogen per acre.

The prairie hay plots were not fertilized.

Grain and Forage Yields

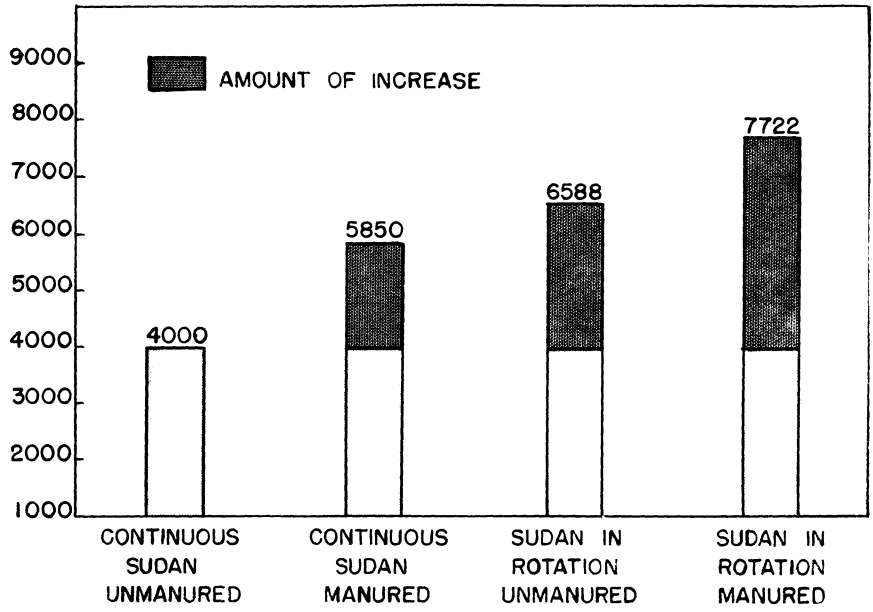
OATS

Oat yields averaged 27.4 bushels per acre on the unmanured rotation plots during the ten years, and the manure increased this yield by 6.1 bushels (Table I). Although these oat yields are low, they are equal to yields obtained when spring oats were planted in

FIGURE 1

Acre Yield of Sudan Grass Hay; in Rotation and Grown Continuously on the Same Land.

(14-year average; pounds per acre)



7-inch rows on similar soil;* and they do produce some income from the land while the sweet clover is being established.

SWEET CLOVER

The yields of sweet clover shown in Table I represent the total production of dry forage just as the plants began to bloom. The 14-year average yield was more than three tons per acre. Yield of the manured plot was 9 percent higher than where manure was not applied.

* See Okla. Agri. Exp. Sta. Bul. B-298, "Wide Row Planting of Small Grains to Establish Sweet Clover and Lespedeza," by Horace J. Harper (June, 1946).

SUDAN GRASS

Figure 1 and Appendix Table I show the yields of Sudan grass in the rotation, and also on the plots where it was planted every year. Average yields of dry hay per acre were:

In the rotation, following sweet clover: manured, 3.86 tons; without manure, 3.29 tons.

Continuous Sudan: manured, 2.92 tons; without manure, 2.00 tons.

More than one cutting of hay was obtained during several seasons, on both the rotation and continuous plots.

SORGHUM

Half of each sorghum plot was cut for silage and the other half was harvested for grain. Yields are shown in Figures 2 and 3 and Appendix Table II. Grain yields are of interest only as showing the amount of grain present in the silage or bundle feed, since the rotation was planned primarily for forage production.

Silage yields per acre averaged:

In the rotation: manured, 12.8 tons; without manure, 11.9 tons.

Continuous sorghum: manured, 11.5 tons; without manure, 8.3 tons.

Grain yields per acre averaged:

In the rotation: manured, 23.6 bushels; without manure, 21.0 bushels.

Continuous sorghum: manured, 20.0 bushels; without manure, 15.7 bushels.

RYE

Beginning in 1948, Abruzzi rye was planted following second-year sweet clover in the 4-year rotation and also following the continuous Sudan grass. The rye was clipped at intervals to determine the amount of grazing that would have been produced. The green forage yield from the rye follow-

FIGURE 2

Average Yields of Sorghum Grain; in Rotation, and Grown Continuously on the Same Land.

(14-year average; bushels per acre)

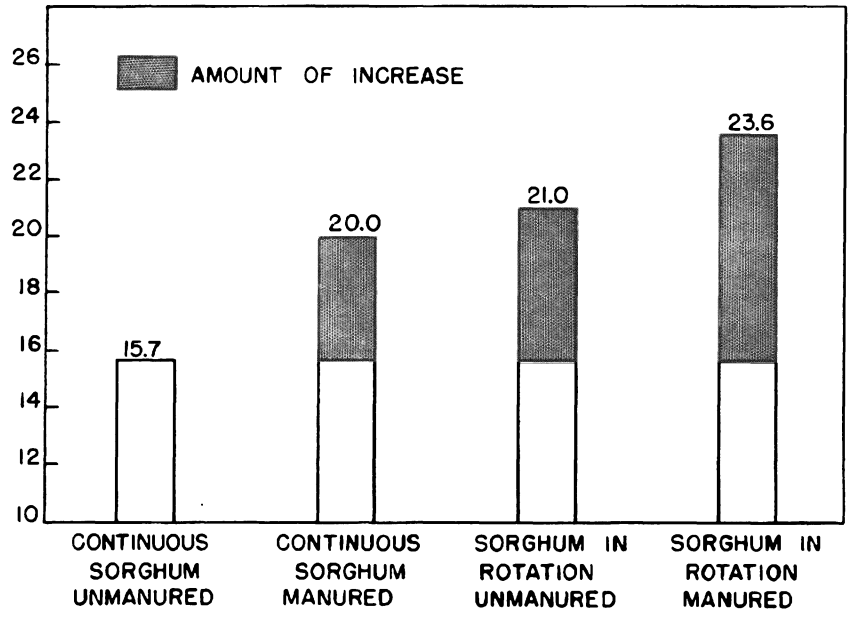
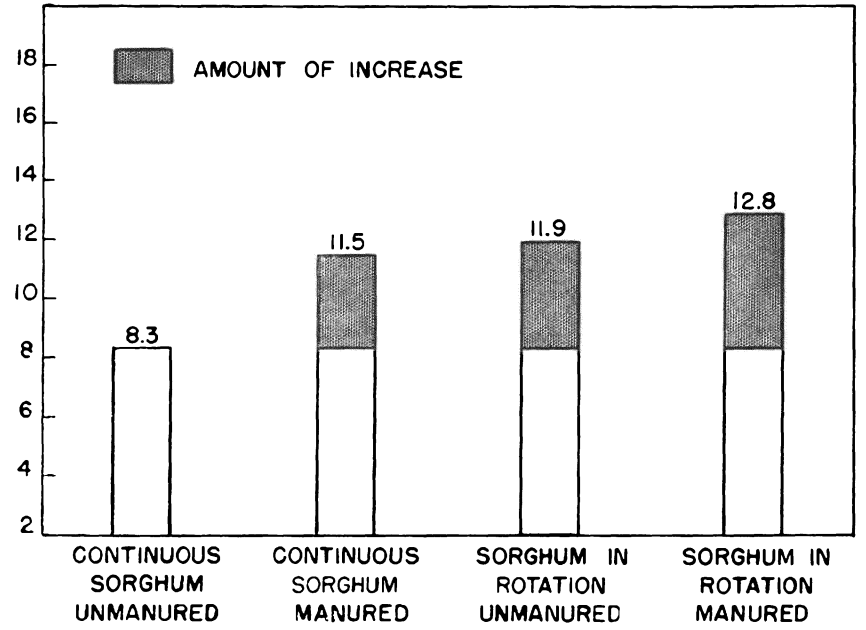


FIGURE 3

Average Yields of Sorghum Silage; in Rotation, and Grown Continuously on the Same Land.

(14-year average; tons per acre)



ing sweet clover during the winter months averaged 4,547 pounds. Following Sudan, yields were only 2,176 pounds. (Table II).

Protein Yields

Protein production was calculated for the crops in the rotation, and for prairie hay on an adjacent area, for the last six years of the test. The results (Table III) show that four acres in prairie hay would have produced only 747 pounds of protein as compared to 2,418 pounds of protein from an equal acre planted in the sweet clover rotation.

Effect on Soil Fertility

The protein content of a non-legumes crop is a direct indication of the amount of nitrogen that crop removes from the soil. (Protein is usually calculated as being 6.25 times the weight of the nitrogen it contains.) Therefore, the amount of nitrogen removed by each crop can be calculated from the data given in Table III. Manure was used in the rotation to replace nitrogen removed by the crops. Sweet clover will replace some of the nitrogen removed but should not be counted on to replace all of it.

TABLE II.—Monthly Acre Yield of Rye Forage Following Continuous Sudan and Following Sweet Clover in Rotation.

(Pounds of clippings)

Winter season	December		January		February		March		April		Total	
	Continuous Sudan	Sw. Cl. in Rotation	Continuous Sudan	Sw. Cl. in Rotation	Continuous Sudan	Sw. Cl. in Rotation	Continuous Sudan	Sw. Cl. in Rotation	Continuous Sudan	Sw. Cl. in Rotation	Continuous Sudan	Sw. Cl. in Rotation
1948-49	1,544	2,195	0	0	0	0	652	1,218	2,109	2,487	4,305	5,900
1949-50	2,209	6,370	750	897	185	526	128	470	563	1,167	3,335	9,430
1950-51	1,172	1,745	218	651	163	324	300	424	615	1,108	2,468	4,252
1951-52	545	1,061	238	435	214	720	189	432	337	863	1,483	3,511
1952-53	0	0	0	0	0	0	253	740	412	2,462	665	3,202
1953-54	0	0	309	272	0	0	245	335	246	381	800	988
Average	905	1,895	167	376	94	262	294	603	712	1,411	2,176	4,547

General Comments

SOIL TREATMENT

Recent soil tests of the plots in this rotation indicate that lime should be applied every 10 to 12 years on this sandy soil to maintain a favorable condition for the growth of sweet clover. Sufficient quantities of lime should be used to neutralize the acids produced by the decay of the sweet clover residues.

Rock phosphate was used instead of superphosphate because it is somewhat less expensive, and also because sweet clover can utilize the phosphorus from rock phosphate more effectively than most crops. When sweet clover residues decay in the soil, the phosphorus they contain is released in forms readily available to succeeding crops. The decay also produces acids which dissolve the inorganic phosphorus in the soil, changing it to a form more readily absorbed by other plants.

CROPS

Sweet Clover

Sweet clover was used as the soil improving crop in this rotation because previous research shows it is one of the best crops available for adding nitrogen to the soil in central and eastern Oklahoma. Also, as noted above, the decay of sweet clover residues will change some of the soil phosphorus into a form easily used by other crops. Sweet clover is essential in a forage crop rotation to maintain yields of other crops on land where the organic matter content of the surface soil is less than 1.5 percent.

Sweet clover provides some grazing during the fall of the first season unless summer drouth is severe,

TABLE III.—Yields and Protein Production on Unmanured Plots in the Rotation, As Compared with the Same Acreage in Prairie Hay, Average 1948-1954.

(Pounds per acre)

	Yield	Protein Content
Oats (grain)	877	108
Sweet clover (hay)	5,693	780
Rye (clippings)	1,591*	441
Sudan grass (hay)	6,588	494
Sorghum (silage)	11,900*	595
Total from 4 acres in rotation	26,649	2,418
Total from 4 acres in prairie hay	10,240	747

* Figures represent dry weight.

and abundant grazing during the spring and early summer of the second year.

The late-maturing variety Evergreen was used because in other Station tests it has produced about 50 percent more forage than yellow-blossom Madrid, and can be grazed about three weeks longer in early summer the second year.

Another advantage of sweet clover is that it matures in early July, leaving the land clear for summer tillage to provide a favorable condition for planting a fall-sown small grain for winter pasture.

If a grass seed drill is not available, the sweet clover can be broadcast at the rate of 12 to 15 pounds per acre. Rolling the soil after planting sweet clover on a loose seed bed will provide a more favorable condition for the early development of sweet clover seedlings. This is often a limiting factor in the survival of the sweet clover plants when early summer drouth is severe.

Oats

Spring oats was used in this rotation because in other Experiment Station trials this crop planted in 14-inch rows has generally proved to be the best nurse crop for sweet clover. Barley is also a good nurse crop for sweet clover, but it needs a more fertile soil than oats. Wheat and rye take more moisture from the soil than do either oats or barley, therefore the sweet clover seedlings are left in a poorer condition to survive summer drouth.

Sudan Grass

Sudan grass can be used for summer pasture or can be cut for hay. When it is planted early, chinchbugs as a rule do not cause much damage to the first crop. Two cuttings of hay are normally obtained. Occasionally three cuttings can be made when rainfall is favorable for summer growth.

More grazing might be obtained by planting Sudan grass on the contour in 21-inch rows, instead of in 7-inch rows as was done in this experiment. When Sudan is planted in 21-inch rows, less forage is destroyed by tramping, and summer growth can be stimulated by operating a sweep between the rows in late June or early July.

Forage Sorghum

At the time this test was started, Atlas was the highest-producing forage sorghum in Station trials. Since then other varieties have been producing higher yields. Varieties currently recommended are Sumac 1712, Sugar Drip, and Leoti.

APPENDIX TABLE I.—Acre Yield of Sudan Grass Hay; in Rotation, and Continuously on the Same Land.

(Pounds)

Year	In Rotation*		Continuous	
	Manured	Unmanured	Manured	Unmanured
1941	3,323	4,138	3,250	3,233
1942	7,415	7,708	8,295	6,035
1943	4,645	4,105	4,250	2,705
1944	13,150	11,325	8,475	6,325
1945	10,450	10,092	7,683	6,117
1946	8,627	7,878	6,573	4,392
1947	10,129	7,197	6,374	4,175
1948	3,875	3,437	3,710	2,910
1949	8,488	7,204	6,718	5,263
1950	9,893	7,778	5,719	3,266
1951	9,800	6,800	6,000	3,600
1952	6,180	4,026	5,634	3,040
1953	8,400	7,200	5,200	3,000
1954	3,730	3,346	4,020	1,962
Average	7,722	6,588	5,850	4,000

* Following Sweet Clover.

APPENDIX TABLE II.—Acre Yields of Sorghum Silage and Sorghum Grain; in Rotation, and Continuously on the Same Land.

Year	In Rotation		Continuous	
	Manured	Unmanured	Manured	Unmanured
	Silage (tons)			
1941	10.8	11.0	11.4	8.5
1942	12.5	11.2	12.6	10.9
1943	6.1	7.0	6.0	4.8
1944	15.1	15.8	14.6	12.6
1945	17.1	14.5	14.0	8.5
1946	9.0	8.0	10.4	7.6
1947	14.7	14.0	11.8	9.4
1948	14.4	12.5	12.1	9.9
1949	19.8	18.3	16.0	9.4
1950	13.7	14.0	14.8	8.9
1951	15.8	14.0	11.9	7.3
1952	9.2	10.5	7.7	6.6
1953	14.0	11.3	11.7	7.8
1954	6.7	5.6	6.0	4.0
Average	12.8	11.9	11.5	8.3
	Grain (bushels)			
1941	29.1	26.8	26.6	21.1
1942	27.0	25.5	33.2	24.4
1943	4.2	5.1	6.6	5.1
1944	40.6	38.6	38.1	31.5
1945	41.8	33.1	39.9	26.3
1946	15.2	13.5	9.7	8.1
1947	12.9	11.8	10.6	9.6
1948	28.7	22.7	14.3	14.1
1949	16.9	14.0	12.3	11.4
1950	23.6	20.0	11.3	14.5
1951	18.3	23.2	15.4	14.7
1952	38.0	32.1	35.8	20.6
1953	24.8	28.5	26.5	19.2
1954	---	---	---	---
Average	23.6	21.0	20.0	15.7

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