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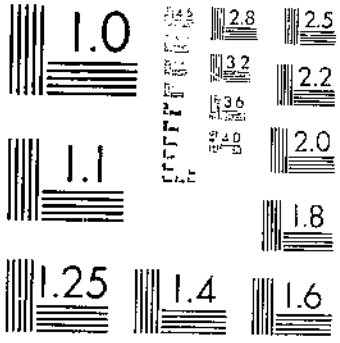

MICROCOPY RESOLUTION TEST CHART
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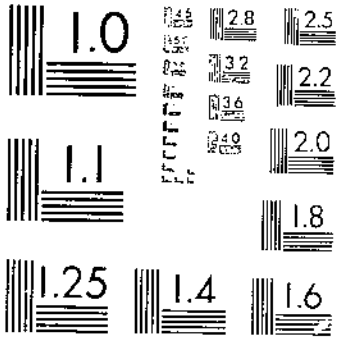

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ROTATION AND TILLAGE EXPERIMENTS AT THE LAWTON (OKLA.) FIELD STATION, 1917–1930

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INTRODUCTION

In 1915 the Division of Dry Land Agriculture of the United States Department of Agriculture established and began operating the United States Dry Land Field Station near Lawton, in southwestern Oklahoma, close to the eastern limit of the southern Great Plains. The altitude of the station is approximately 1,150 feet, and the annual precipitation there is nearly 31 inches.

The station at Lawton is representative of a large area in southwestern Oklahoma and northern Texas. No other extensive area in the Great Plains is directly comparable or similar to that in which the Lawton station is located. The average precipitation is heavy enough to warrant the general classification of the section as subhumid rather than semiarid, but it is not so dependable as in other sections where the average is lower. The rainfall is often torrential, and its monthly distribution is variable. The summers are frequently long and hot, and more or less protracted periods of drought are common. Conditions highly favorable to the growth of tender vegetation may suddenly change to conditions that are common to arid regions where plant growth is continually dwarfed and stunted.

Soils differ widely in structure and composition in this section, where erosion is great enough to be a problem on most farms.

Destructive insects frequently take a heavy toll of one or more crops and reduce the farm revenues to a small margin of profit and

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often cause loss. The chief insect enemies are the chinch bug (*Blissus leucopterus*), the boll weevil (*Anthonomus grandis*), and several species of worms.

This part of the State is drained by a great many intermittent streams flowing in a southerly direction. These streams are small, but occasionally overflow, with considerable damage to adjacent farm lands. They are usually bordered with some timber, which is used chiefly for fuel. Some pecans grow and are harvested in these belts of timber. Adjacent to the creeks and rivers there is much valuable farm land with a productive soil that responds readily and dependably to good husbandry.

The section is comparatively new, much of southwestern Oklahoma having been opened to the home seeker in 1901. It has undergone a rapid and permanent development in the transition from well-grassed plains, that supported large herds of grazing beef cattle, to the plow and the small home farm. Crop practices and farm operations have been gradually adapted to meet climatic demands and other hazards. Wherever the human effort in this scheme of development has been directed aggressively, persistently, carefully, and intelligently, farm life has been attended with a moderate degree of success.

CROPS GROWN IN THE REGION

A large variety of crops is grown, each crop occupying a place in farm practice determined by its adaptability to individual farm needs and plans and to the equipment and facilities for handling it.

Alfalfa is grown quite successfully on bottom land, but to a very limited extent and with little success on the upland. The same is true of sweetclover, which, however, does not replace alfalfa or assume equal importance on the bottom or subirrigated lands.

Attempts to grow corn on the upland were continued for many years, but results were so universally unprofitable that corn is seldom planted now on such land, its production being confined to sandy bottom-land fields, where moisture conditions are more favorable. Even under the most favorable conditions the quality of corn is only fair, and the yields fluctuate widely.

Winter barley, although grown occasionally for many years, was not important in crop production until 1919. Thereafter the acreage increased with marked rapidity, and now the crop is recognized as important. Winterkilling has been the limiting factor in the production of this crop three times in the 12 years from 1919 to 1930. Its value as a fall, winter, and spring pasture crop is almost as high as the feed or cash value of the grain produced.

Oats are a dependable feed crop which finds a place in the management and operation of nearly every farm. The new varieties, Fulghum and Kanota, introduced in recent years, are rapidly supplanting the Texas Red variety that previously was grown universally.

Kafir, feterita, and sorgo are grown primarily as feed crops and are relied upon extensively because of their ability to withstand adverse conditions. This does not apply strictly to feterita, which is grown in a small way either for late feed or as a late catch crop.

The acreage of broomcorn varies from year to year according to the market, which is subject to wide fluctuations. This crop is produced most profitably on the sandy soils.

Wheat and cotton are grown extensively and are the principal cash crops. Cotton occupies approximately one-third of the cultivated farm acreage. Probably no other crop is so well suited to the hot, droughty periods as cotton. It has an important place, even on farms that have sound systems of diversification. Hard and soft varieties of winter wheat are grown in about equal proportion. In recent years there has been a decided tendency to increase the acreage of hard wheat. The dividing line between the hard and soft wheat belts of the State extends from north to south through the vicinity of Lawton. The recent development of power farming adapted to wheat, oats, and barley has increased the acreage of these small-grain crops. It is likely, however, that the increased acreage will be confined largely to wheat, which is a cash crop, rather than to oats and barley, which are grown primarily as feed crops.

Cowpeas are grown commonly on both tight soil and sandy soil. The crop is dependable, but returns largest yields when grown on sandy soil. The difficulty of harvesting cowpeas satisfactorily and of curing the hay restricts the acreage to a point where such varieties as may best be used for human consumption are generally grown.

DESCRIPTION OF THE STATION

The experiment station consists of 160 acres of gently rolling upland. Three distinct drainage courses pass through the farm in a southerly direction, making much of it unsuitable for experimental purposes. In general, the land slopes gently to the east, but the breaks in topography give some of the fields a slope in three directions.

The soil is a reddish-brown clay loam having a high clay content with a medium supply of organic matter and of fairly good natural fertility. It is classified[1] as Tishomingo and is representative of an isolated area in the red prairies. The surface soil varies in depth from 6 to 12 inches and is underlain by a compact subsoil of reddish-brown to red clay that resists the penetration of water and plant roots. The surface soil is easily compacted, which favors the rapid run-off of storm water, and its shallowness restricts and limits the water-storage capacity. The natural water-holding capacity of the soil is fairly high, but its lack of depth makes crops largely dependent upon a well-distributed rainfall during the growing season.

Fragmental rocks from 1 to 12 inches in diameter permeate the subsoil without any regular formation and frequently outcrop at the surface. They are derived from several kinds of crystalline rocks, mainly of a granitic nature. Small waterworn gravel and rounded calcareous concretions are usually present in both the surface and the subsoil. This occurrence of rock marks the termination of the low, mountainous foothill region lying about 14 miles to the north and the northwest.

The native vegetation is representative of the section. Bluestem bunch grass (*Andropogon scoparius*) constitutes the chief plant cover. Herbaceous plants and other short grasses are well interspersed. When not overstocked, these grasses support a very satisfactory amount of grazing, and when not grazed they may be profitably cut for hay.

[1] BENNETT, H. H. THE SOILS AND AGRICULTURE OF THE SOUTHERN STATES. 399 p., illus., New York. 1921.

CLIMATIC CONDITIONS

Records of precipitation have been kept at Lawton and its vicinity for the 60 years from 1871 to 1930, except 1883 and 1884. The 58-year average annual precipitation is 30.85 inches. There is an extremely wide fluctuation in the annual precipitation, the lowest on record being about 15 inches and the highest about 59 inches.

During the 14 years from 1917 to 1930, when the experimental work on the station as reported in this bulletin was done, the annual precipitation at the station ranged from 17.28 to 43.65 inches and averaged 29.58 inches. The monthly, seasonal, and annual precipitation during this period and the 58-year monthly averages for Lawton and vicinity are given in Table 1.

TABLE 1.—*Monthly, seasonal, and annual precipitation at the Lawton field station, 1917–1930, compared with the averages for Lawton and vicinity for 58 years*

[Data in inches. T=trace]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal, April to September	Annual
1917	0.30	0.57	1.74	1.28	4.50	1.01	3.02	2.84	0.72	0.19	1.08	0.03	13.37	17.28
1918	.20	.25	2.16	2.36	1.29	3.08	2.57	1.48	4.18	8.68	1.20	3.50	14.96	30.95
1919	.54	1.41	2.99	4.60	5.44	4.36	3.71	1.98	1.67	13.78	2.25	.92	21.76	43.65
1920	1.04	.61	1.84	3.14	7.53	.69	1.88	4.18	2.05	8.78	2.20	.86	19.47	34.89
1921	1.15	1.47	2.05	2.14	1.30	5.83	2.95	.83	2.13	.03	T	.53	15.28	20.51
1922	.89	.46	.97	6.85	6.03	1.01	3.40	.64	1.61	2.46	1.04	.21	20.14	26.17
1923	4.37	.70	1.30	3.48	5.56	2.68	1.25	1.79	4.99	9.04	3.51	1.76	19.75	40.43
1924	.20	.11	2.47	3.88	3.05	3.36	1.39	4.15	.61	.78	.50	.99	16.44	21.49
1925	.95	.82	T	5.78	2.00	.65	2.01	3.52	7.73	3.58	1.83	.11	21.60	28.98
1926	1.33	0	1.67	2.22	3.79	1.20	2.19	7.48	4.07	4.78	.22	4.50	21.46	33.96
1927	1.45	1.41	2.37	3.22	3.17	2.71	3.44	2.65	4.67	1.71	.72	1.33	19.86	28.85
1928	.59	1.25	1.08	1.90	2.78	8.01	2.28	1.21	.60	2.02	2.67	1.28	10.84	25.74
1929	.94	.80	3.10	.01	12.26	1.94	3.15	.31	4.43	2.30	1.25	.23	22.10	30.72
1930	.82	.19	.26	4.08	5.75	2.47	.57	.55	1.70	9.74	1.64	2.67	15.12	30.44
Average, 14 years	1.06	.72	1.71	3.21	4.65	2.79	2.41	2.40	2.99	4.85	1.44	1.35	18.45	29.58
Average, 58 years	1.08	1.10	1.63	3.03	5.05	3.46	3.06	2.89	3.13	3.01	1.81	1.60	20.02	30.85

The annual precipitation, however, has but little value as an index to the possibilities of crop production. The seasonal distribution of the precipitation, temperatures, humidity, wind velocity, and evaporation are the important climatic factors in this connection. In 1918 the annual precipitation was about normal, but crops were the poorest in the history of the station. In 1924 the precipitation was only 21.49 inches and crops were at the peak of production.

Evaporation was measured by daily readings of the change in the water level of a tank 24 inches deep and 6 feet in diameter sunk in the ground to a depth of 20 inches and kept filled to about the level of the ground. At most stations the evaporation is measured for the six months from April to September, but at Lawton the season is so long that the measurements were continued through November. The monthly evaporation during the months in which it was measured from 1917 to 1930, inclusive, is given in Table 2. For comparison with data from other stations, the totals for the six months from April to September are given, as well as the totals for the eight

months from April to November. The average seasonal evaporation for the six months was 43.482 inches and for the eight months 50.605 inches. Evaporation is highest during July and August, when the humidity is low, temperatures are high, and the rainfall is usually scant.

TABLE 2.—*Average monthly evaporation at the Lawton field station from April to November, inclusive, for the 14 years 1917–1930, with totals for 6-month and 8-month periods*

[Data in inches]

Year	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Total	
									Apr.–Sept.	Apr.–Nov.
1917	8.402	7.310	10.240	10.064	8.514	6.495	7.465	3.602	51.025	62.032
1918	6.138	8.826	7.909	10.528	12.132	6.773	3.796	2.541	52.396	58.733
1919	4.756	5.405	5.357	7.183	8.213	6.103	3.670	2.299	37.017	42.386
1920	7.084	5.088	7.647	7.984	5.236	5.292	3.866	2.242	38.331	44.439
1921	5.205	6.412	5.139	7.045	8.101	6.851	5.746	3.533	38.753	48.032
1922	4.418	4.615	6.533	8.586	8.791	6.626	4.637	2.328	39.563	46.528
1923	4.670	6.402	7.096	8.665	9.952	5.358	3.019	1.799	42.233	47.051
1924	5.190	5.099	9.067	8.056	8.716	6.392	4.775	3.354	43.520	51.649
1925	6.979	6.014	10.364	11.594	7.619	6.152	3.823	2.519	48.692	55.034
1926	4.671	6.353	9.011	8.739	8.242	5.625	3.905	3.469	42.641	50.015
1927	5.061	7.882	7.572	7.856	7.643	6.185	3.930	3.168	42.229	49.327
1928	5.111	6.151	6.324	7.604	7.973	7.521	6.140	2.531	40.684	49.355
1929	5.414	5.834	8.476	8.549	10.269	5.001	4.113	2.15'	43.543	49.810
1930	6.254	5.508	7.747	10.466	10.097	8.052	3.388	2.563	48.124	54.075
Average	5.668	6.285	7.755	8.780	8.678	6.316	4.401	2.722	43.482	50.605

Wind velocity was measured by a Robinson 4-cup anemometer exposed at a height of 2 feet above the ground. The average monthly wind velocity for the 14 years from 1917 to 1930 is given in Table 3. The average wind velocity is comparatively low, except in March and April, when an average velocity of 7 or 8 miles an hour may be expected.

TABLE 3.—*Average monthly wind velocity (in miles per hour) measured at 2 feet from the ground at the Lawton field station for the 14 years 1917–1930*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1917	5.8	3.8	10.0	10.8	7.8	7.0	6.2	5.2	4.6	7.7	5.3	6.7
1918	7.8	6.7	6.7	7.9	9.6	4.7	5.8	6.1	5.3	3.9	5.6	5.1
1919	4.4	7.4	6.9	6.7	4.9	3.3	4.0	4.6	5.5	5.9	5.2	6.8
1920	4.9	5.6	8.8	9.0	5.5	5.1	3.8	4.1	4.7	5.7	5.4	5.9
1921	6.4	6.0	7.9	8.1	6.1	4.5	4.3	4.4	5.8	6.1	5.5	6.5
1922	6.4	8.6	9.9	7.8	5.5	3.9	4.8	4.1	3.6	4.2	5.0	5.7
1923	5.4	6.4	9.7	7.6	6.9	5.2	3.3	4.6	4.0	4.4	4.0	6.6
1924	6.2	6.8	7.2	6.2	5.2	6.3	4.6	5.3	4.4	3.7	5.1	5.0
1925	5.7	6.8	8.0	7.5	5.1	5.9	5.5	3.3	3.8	5.0	4.4	5.8
1926	6.6	7.1	7.7	6.8	5.3	5.1	4.2	3.9	4.4	3.8	5.8	6.0
1927	6.3	7.7	8.1	6.7	7.1	4.8	3.7	4.2	5.4	4.5	6.9	6.4
1928	5.9	6.7	7.3	9.0	5.9	6.6	4.1	3.6	4.0	6.4	6.9	6.5
1929	8.2	7.5	8.6	8.0	7.4	6.1	4.1	3.9	3.4	4.0	5.2	4.7
1930	6.6	6.9	7.6	7.4	6.4	6.2	4.3	3.4	4.7	4.8	5.1	5.5
Average	6.2	6.6	8.2	7.8	6.3	5.3	4.5	4.3	4.5	5.0	5.4	5.9

The mean monthly maximum and minimum temperatures for the 14-year period from 1917 to 1930 are given in Table 4.

TABLE 4.—*Mean monthly maximum and minimum temperatures (°F.) at the Lawton field station for the 14 years 1917–1930*

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1917	54	24	56	26	67	38	74	48	77	52	93	61	97	69	93	67	89	60	75	42	68	39	43	23
1918	41	17	60	30	71	42	70	46	86	62	96	70	97	70	101	71	81	55	75	54	57	41	52	32
1919	49	28	51	30	63	41	70	48	76	57	84	65	91	69	94	69	85	64	70	52	58	35	46	25
1920	46	28	55	32	65	38	71	44	79	59	87	65	93	69	87	65	86	62	76	53	57	35	54	27
1921	55	33	58	30	68	43	71	47	82	59	86	67	92	70	97	70	92	67	80	48	66	33	56	29
1922	47	25	58	29	64	38	71	51	79	59	90	66	96	69	99	70	90	61	77	49	63	40	55	29
1923	62	33	49	29	60	33	73	49	79	57	87	67	97	70	97	69	85	64	65	49	60	39	52	32
1924	47	21	54	29	54	33	71	48	76	52	94	69	92	68	96	71	84	55	80	49	67	38	45	21
1925	47	23	63	30	72	41	80	55	79	57	97	70	98	72	92	68	87	65	65	44	62	35	52	25
1926	47	25	63	32	58	37	67	44	81	57	91	64	93	68	94	68	84	63	76	53	61	33	49	30
1927	50	27	58	35	64	39	76	51	86	61	88	65	92	68	91	67	86	62	80	49	68	41	47	22
1928	54	27	55	31	67	39	70	46	83	57	85	65	92	70	94	68	89	58	81	53	58	38	53	28
1929	48	24	40	23	66	35	78	52	76	56	90	67	93	69	99	69	84	60	75	51	52	32	57	27
1930	33	14	64	35	63	35	82	53	79	57	89	67	97	69	99	69	91	64	69	50	62	37	49	29
Average	49	25	56	30	64	38	73	49	80	57	90	66	94	69	95	69	87	61	75	50	61	37	51	27

The long-time average frost-free period of 214 days provides a long growing season which permits the production of a wide variety of cash and feed crops. Killing frosts in the spring are a source of danger chiefly to fruit and truck crops. Late-maturing cotton is the only crop likely to suffer frost damage in the autumn. The latest killing frost in the spring on record from 1893 to 1930 occurred May 1, 1903, and the earliest killing frost in autumn was on September 26, 1912. Table 5 gives the frost data for the 14-year period from 1917 to 1930. The average frost-free season during this period was 219 days.

TABLE 5.—*Dates of the last killing frost in spring and the first in autumn and the number of frost-free days at the Lawton field station for the 14 years 1917–1930*

Year	Last frost in spring	First frost in autumn	Length of frost-free season (days)	Year	Last frost in spring	First frost in autumn	Length of frost-free season (days)
1917	Apr. 8	Oct. 19	194	1925	Mar. 15	Oct. 27	223
1918	Apr. 9	Nov. 18	223	1926	Apr. 14	Nov. 4	204
1919	Mar. 11	Nov. 10	244	1927	Mar. 19	Nov. 15	241
1920	Apr. 4	Nov. 1	211	1928	Mar. 29	Nov. 3	219
1921	Apr. 17	Nov. 10	207	1929	Mar. 16	Oct. 24	222
1922	Mar. 12	Nov. 13	246	1930	Mar. 30	Oct. 31	215
1923	Apr. 5	Nov. 5	214				
1924	Mar. 31	Oct. 23	206	Average	Mar. 29	Nov. 3	219

ROTATION AND TILLAGE EXPERIMENTS

Crop rotation and tillage experiments are conducted on 0.1-acre plots. The crops grown are winter wheat, oats, winter barley, spring barley, rye, cotton, peanuts, cowpeas, alfalfa, sweetclover, corn, kafir, sorgo, feterita, and broomcorn. The rotations are from two to six years in length, but the greater part of the work is with 2-year and 3-year rotations. Experiments in continuous cropping and methods of tillage include cotton, broomcorn, corn, sorgo, kafir,

feterita, and winter wheat. These experiments are carried on in two separate fields, known as field A and field B.

All the experiments in which there are grain sorghums, forage sorghums, and corn are in field A, and all in which there are small-grain crops, except oats, are in field B. This arrangement was made necessary because of the severe damage to the row crops from the chinch bug. When feed and forage crops are grown adjacent to wheat or barley, the chinch bug has proved to be the largest single menace or hazard to experimental production and was responsible for low yields and failures when climatic conditions were favorable to average or better yields. The damage by the insect is responsible for breaks in the continuity of many experiments, made because it became necessary to revise rotations and place them in new locations. These adjustments were resorted to only after several years of attempting to combat the damage and to protect the continuity of the work begun in 1916.

It is readily recognized that the risk and danger involved in protecting and producing a crop yield from a small area, such as an experimental plot that is directly exposed to a heavy migration and concentration of chinch bugs, is much greater than on the average farm field, where a small loss may be sustained while measures designed to reduce the infestation are being established. The chinch bugs have well-known and decided crop preferences, and their behavior during the season as various crops mature may be pretty definitely anticipated. It has become a well-established practice to separate small grain crops as widely as possible from row crops of grain sorghums, forage sorghums, and corn. In the organization and establishment of cropping systems and rotations the hazard of destructive crop insects becomes a factor equal in importance to that of soil and climate.

During the years in which experiments in crop production have been conducted at Lawton, conditions that influence crop yields have presented extreme variations.

A combination of crop rotations and tillage methods with different crops provides a number of comparisons between spring plowing and fall plowing, listing, and disking.

Fall plowing is done as soon as practicable after the crop is removed. However, the nature of the crop previously grown may extend this operation over a rather long period. After corn such plowing may be done in October, but after cotton the same operation is not generally possible until December and often later, when it might well be termed winter plowing.

The preparation of land for small grain after wheat, oats, and barley has considerable latitude in time. These crops are usually harvested in the latter part of May and in early June, but seeding of wheat and winter barley may be done as early as September 1 and as late as December 1, although the practicability of late seeding is questionable. Oats, on the other hand, are generally seeded early in February; sometimes sooner, if the weather permits.

RESULTS WITH CORN

Although the impracticability of growing corn on the tight upland soils of southwestern Oklahoma is definitely recognized, a limited amount of experimental work on methods of tillage and crop se-

quence has been done. The results are presented in Table 6. In the continuous record of corn production for the 14-year period 1917 to 1930, three entire failures of grain were recorded and four years of low yields, when the quality of the grain produced was scarcely marketable. The wide fluctuations in annual yields from total failures in 1917, 1918, and 1925, to an average yield of 36.7 bushels to the acre in 1919, emphasize the uncertainty of production. The 14-year average yield under each method is so low that the slight advantage of one over the other has but little significance. The quality of the grain, with but few exceptions, was very inferior.

A slight increase in the production of both grain and stover when corn is grown continuously resulted from subsoiling, but this method is too expensive to justify the extra labor involved. Barnyard manure applied as a top-dressing on spring-plowed land gave a greater increase in the yield of stover than in the yield of grain.

Corn on spring-plowed oat land produced the lowest average yield for the 14-year period. This method of production is involved in a 6-year rotation originally arranged as follows: Oats, corn, wheat, and three years of alfalfa. Beginning with the crop year of 1922, wheat was replaced by cotton. This rotation is so located in field A that the corn has always been subject to heavy damage from chinch bugs that migrate from near-by areas of native grass.

The 14-year averages from 1917 to 1930, inclusive, are somewhat lower than those of the six years from 1917 to 1922, but the relative performances of the different methods of tillage and crop sequence are practically the same for the two periods.

With respect to the results presented for only the six years from 1917 to 1922, it should be explained that where corn follows milo the milo was the second crop in a single year, being planted on wheat stubble as soon as possible after harvest. Cowpeas and rye used as green-manure crops for corn were sown after winter wheat was harvested.

Milo grown in this manner produced but two yields of grain in the six years—2.9 and 11.7 bushels to the acre in 1917 and 1920, respectively. Corn and milo were so frequently damaged by chinch bugs that the results do not warrant detailed analysis and study. There is some possibility of growing a second crop in a single year when moisture conditions are unusually favorable, but the extent to which this practice may be followed is governed by rainfall and the presence of destructive crop insects, and its advisability depends upon the demand for feed and the subsequent effect on the crop to be grown the following year.

Regardless of the quantity of water stored in the soil, temperature, humidity, wind movement, and insects constitute hazards during the period of growth and development of the corn crop that usually eliminate most of the advantages that might have been obtained from a well designed and executed method of tillage. Nevertheless, as a sound farm principle and intelligent practice, tillage designed to eliminate weed growth should accompany the attempted production of corn.

TABLE 6.—*Acre yields of corn grown by different methods at the Lawton field station, 1917–1930*

GRAIN (bushels)

Previous crop and treatment	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average 1917–1930	Average 1917–1922
Corn:																
Spring plowed	0	0	42.7	21.5	32.2	11.3	11.1	14.7	0	7.1	22.0	16.8	25.1	2.3	14.8	18.0
Spring plowed, top-dressed	0	0	43.3	21.6	45.0	22.9	10.5	20.3	0	10.9	28.3	26.0	38.0	14.8	20.1	22.1
Fall plowed	0	0	40.1	24.1	38.8	12.6	13.7	14.5	0	6.3	23.6	18.3	25.9	2.5	15.0	17.6
Fall plowed, subsoiled	0	0	49.2	29.5	40.7	17.9	15.1	19.5	0	12.1	26.5	25.1	27.2	8.3	19.4	22.9
Listed	0	0	35.1	25.8	32.5	11.6	7.3	17.0	0	11.3	13.3	20.2	26.6	11.0	15.1	17.5
Oats:																
Spring plowed	0	0	32.9	18.3	29.3	12.3	5.2	16.0	0	0	18.9	13.7	26.8	2.1	12.5	15.5
Fallowed	0	0	49.5	24.9	46.7	16.9	16.9	19.1	0	16.5	24.8	24.7	29.6	8.7	19.9	23.0
Sorgo:																
Fall plowed							14.5	13.2	0	0	26.1	16.4	26.4	0	[1] 12.1	
Wheat and milo:																
Spring plowed	0	0	31.6	14.3	28.5	5.0										13.2
Wheat:																
Spring plowed	0	0	30.0	18.9	25.4	7.0										13.6
Spring plowed, manured	0	0	30.7	23.6	38.8	4.7										16.3
Wheat, cowpeas:																
Green manured	0	0	32.3	14.7	27.6	2.7										12.9
Wheat, rye:																
Green manured	0	0	22.7	12.1	19.6	3.1										9.6

STOVER (pounds)

Corn:																
Spring plowed	2,050	1,700	3,700	2,300	3,000	1,650	1,900	1,300	650	1,300	1,250	1,350	1,400	1,080	1,759	2,400
Spring plowed, top-dressed	2,950	2,350	5,100	4,100	4,850	3,100	1,600	2,000	1,350	1,350	2,000	2,300	2,900	1,340	2,664	3,742
Fall plowed	2,300	1,750	3,550	2,450	2,800	1,500	1,900	1,500	800	1,150	1,300	1,350	1,450	1,260	1,790	2,392
Fall plowed, subsoiled	2,650	3,400	3,850	2,750	3,700	1,900	2,200	2,000	1,050	1,500	1,250	1,850	1,650	1,130	2,206	3,042
Listed	2,175	2,200	2,525	2,325	2,525	1,925	1,875	1,600	750	1,250	950	1,400	1,350	930	1,699	2,279
Oats:																
Spring plowed	2,000	1,550	2,530	3,180	3,400	1,850	1,950	1,550	750	1,400	1,500	1,850	2,150	1,490	1,939	2,418
Fallowed	2,450	1,750	3,700	2,300	3,700	1,800	2,550	1,750	1,250	1,500	1,350	1,950	2,100	700	2,061	2,617
Sorgo:																
Fall plowed							2,100	1,550	350	2,050	1,550	1,850	1,950	300	[1] 1,463	
Wheat and milo:																
Spring plowed	1,400	900	1,980	2,680	2,500	1,950										1,902
Wheat:																
Spring plowed	1,250	1,300	2,100	2,980	2,700	1,850										2,030
Spring plowed, manured	2,750	2,030	2,650	3,680	3,750	2,300										2,860
Wheat, cowpeas:																
Green manured	1,100	920	2,080	2,850	2,800	1,650										1,900
Wheat, rye:																
Green manured	1,150	880	2,400	2,590	2,850	1,850										1,953

[1] 8-year average.

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RESULTS WITH KAFIR

The results of the crop-rotation and cultivation work with kafir from 1917 to 1930, inclusive, are shown in Tables 7 and 8 and in Figure 1. During the 14 years complete failures of grain from this crop were recorded twice—in 1918 and in 1930. Entire failures of both grain and stover occurred on individual plots in several other seasons. These failures were the results of chinch-bug damage rather than of cultural practices. The wide fluctuation of annual yields and the comparatively small difference in average yields between kafir and corn would indicate that the production of kafir was almost as uncertain as that of corn. However, the crop occupies an important place in the production of feed for individual farm use and is definitely recognized as being more dependable and more productive than corn, especially in the drier years. It is generally necessary to plant corn as early in the spring as possible, usually the latter part

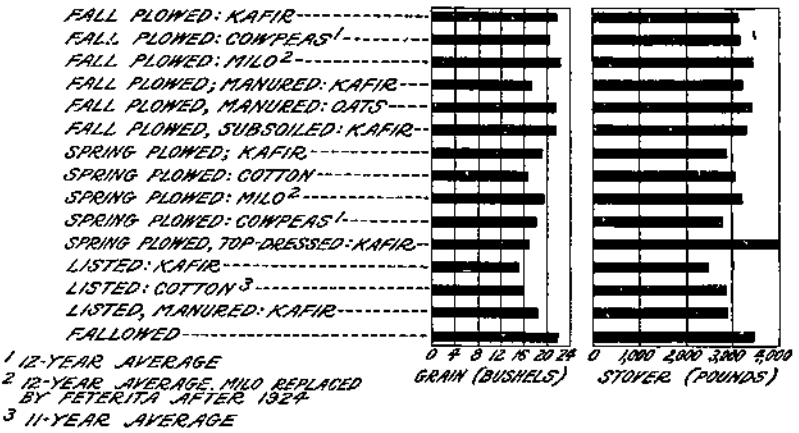

FIGURE 1.—Average yields of kafir grown by different methods at the Lawton field station, 1917–1930

of March or early April. Kafir, however, may be planted from the first part of April to the middle of June, the time depending entirely on climatic and soil conditions. Although the yields may frequently be low, the quality of the grain is almost always superior to that of corn. The yield of kafir stover, which finds a wide use as roughage for livestock, has exceeded the yield of corn stover in comparable tests (Table 12) by an average of 1,288 pounds to the acre.

Fall plowing for kafir increased the yield less than 3 bushels to the acre over spring plowing, irrespective of the preceding crop. In continuous cropping, subsoiling had no influence on the average yield of grain and increased the yield of stover only 116 pounds. The milo that preceded kafir in the rotations made but little plant growth, being destroyed early in the season by chinch bugs. In the attempt to produce milo during the seven years from 1917 to 1923, yields were obtained only three times. Feterita was substituted for milo beginning with the crop of 1924, and became the previous crop instead of milo beginning with 1925. Land previously cropped to cowpeas which were harvested as hay during the 12 years from 1919 to 1930 averaged 2.2 bushels more when fall plowed than it did when spring

plowed. Kafir did not yield as heavily on either fall plowing or spring plowing following cowpeas as it did following kafir.

Kafir on spring-plowed cotton land yielded an average of 2.6 bushels to the acre less than on land continuously spring plowed and cropped to kafir for the 14-year period. The former method proved to be one of the poorest tested.

Kafir, continuously cropped on land that was fall plowed and manured, yielded 4.3 bushels of grain to the acre less than kafir grown by the same method without manure. When manure was applied as a top-dressing on spring-plowed land continuously cropped, the yield of grain was reduced 2 bushels to the acre and the yield of stover increased about 1,200 pounds to the acre as compared with the yield under similar treatment without manure. Fall-plowed oat stubble to which manure was applied gave good yields of both grain and stover, but there was no corresponding treatment without manure.

The reduction in grain yields from the use of manure may be due to several factors. It has been observed that the plants were stimulated to a more rapid succulent growth by the manure. This depleted the soil moisture rapidly and frequently caused the crop to suffer from drought early in the season. The grain was advanced in maturity over surrounding crops, and became subject to bird damage that was difficult to control, especially on small areas.

Manure on continuous cropping was applied annually at the rate of approximately 3 tons to the acre. On the fall-plowed oat land, where the kafir was grown in a 4-year rotation, the manure was applied at the rate of 10 tons to the acre.

As a method of seed-bed preparation for kafir, listing produced lower yields than either spring plowing or fall plowing during the 14 years that it was tested.

In the continuous-cropping series of kafir plots, A is spring plowed, B is fall plowed, and F and G are spring listed. From 1917 to 1920, inclusive, plot F was lister planted without any previous treatment, and plot G was disked in the spring and lister planted at seeding time. Beginning with 1921, both plots were disked in the spring, plot F was shallow listed, and plot G was deep listed at planting time. The 14-year average acre yields of these plots from 1917 to 1930 were A, 19.3 bushels; B, 22.3 bushels; F, 14.1 bushels; and G, 14.8 bushels. The average of plots F and G listed is 6.3 bushels less than the average of plots A and B plowed. The 11-year (1920–1930) average acre yield of kafir continuously cropped on listed land is 0.5 of a bushel less than on listed cotton land. Where manure was applied to kafir continuously cropped on listed land, the 14-year average acre yield was 18.7 bushels, which was 3.8 bushels more than on land with the same treatment without manure. (Table 7.)

The application of manure to kafir on listed land has resulted in a slight increase in grain yields and a decrease in stover yields in comparison with similar applications on either spring-plowed or fall-plowed land.

The problem of securing good, uniform stands on listed land is important. Germination and subsequent growth for a few weeks are slower on listed land than on plowed land that has been surface planted. The probability of stands being reduced by heavy rains when listing is practiced is also greater, and frequently replanting is necessary.

TABLE 7.—*Acre yields of kafir grown by different methods at the Lawton field station, 1917–1930*

GRAIN (bushels)

Treatment and previous crop	Number of plots averaged	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
Fall plowed:																
Kafir	2	19.3	0	31.4	36.2	28.7	3.4	17.1	35.6	11.2	26.8	30.2	34.5	27.8	0	21.6
Cowpeas	1			35.8	34.8	27.5	4.0	12.8	31.0	11.5	13.3	17.5	33.3	24.3	0	[1] 20.5
Milo [2]	2			34.7	42.6	27.3	3.3	14.5	31.0	12.2	24.4	16.1	37.4	20.5	0	[1] 22.0
Average		19.3	0	34.0	37.9	27.8	3.6	14.8	32.5	11.6	21.5	21.3	35.1	24.2	0	20.3
Fall plowed, manured:																
Kafir	1	19.5	0	25.8	34.3	29.3	0	0	28.7	7.7	16.8	33.3	24.0	23.0	0	17.3
Oats	1	16.7	0	43.2	36.8	37.0	0	15.0	37.3	10.8	14.2	37.5	34.3	22.7	0	21.8
Average		18.1	0	34.5	35.6	33.2	0	7.5	33.0	9.3	15.5	35.4	29.2	22.9	0	19.6
Fall plowed, subsoiled:																
Kafir	1	14.5	0	30.7	40.8	29.2	6.2	16.3	33.7	13.0	25.5	27.8	38.8	26.8	0	21.7
Spring plowed:																
Kafir	2	15.5	0	28.8	36.7	24.5	7.2	15.1	28.3	9.5	22.3	21.3	34.4	20.4	0	18.9
Cotton	3	2.3	0	30.3	41.2	24.6	1.2	1.7	31.2	2.7	18.3	15.2	30.2	28.8	0	16.3
Milo [2]	1			27.8	45.2	21.2	7.8	12.5	25.7	10.7	21.8	14.2	25.8	19.5	0	[1] 19.4
Cowpeas	4			29.0	37.8	24.1	1.5	7.5	28.9	15.6	15.7	9.8	30.1	20.1	0	[1] 18.3
Average		8.9	0	29.0	40.2	23.6	4.4	9.2	28.5	9.6	19.5	15.1	30.1	22.2	0	17.2
Spring plowed, top-dressed:																
Kafir	1	12.3	0	7.7	34.0	8.3	5.2	13.2	30.7	15.2	22.2	28.7	33.0	20.7	0	16.9
Listed:																
Kafir	9	13.2	0	24.1	27.3	18.4	1.4	5.5	23.5	13.4	22.4	17.3	24.4	17.2	0	14.9
Cotton	1				32.4	19.2	0	0	30.5	5.7	12.2	28.0	28.3	18.8	0	[3] 15.9
Average		13.2	0	24.1	29.9	18.8	.7	2.8	27.0	9.6	17.3	22.7	26.4	18.0	0	15.0
Listed, manured:																
Kafir	1	17.8	0	25.8	22.5	30.7	2.7	11.0	31.0	15.0	25.8	21.3	29.3	29.2	0	18.7
Fallowed	3	18.7	0	31.1	39.3	28.0	3.2	16.8	33.5	18.8	27.1	21.6	42.9	27.8	0	22.1
Average		18.3	0	28.5	30.9	29.4	3.0	13.9	32.3	16.9	26.5	21.5	36.1	28.5	0	20.4

STOVER (pounds)

Fall plowed:																
Kafir	2	4,970	1,350	4,245	4,255	3,780	1,696	2,335	5,240	1,530	2,720	3,045	3,650	3,655	1,450	3,137
Cowpeas	1	-------	-------	4,700	3,490	3,500	3,440	1,430	4,790	1,760	3,250	1,760	3,950	3,690	2,050	[1] 3,151
Milo [2]	2	-------	-------	4,970	4,945	3,440	4,270	1,855	4,720	2,520	3,550	1,730	4,395	2,895	1,750	[1] 3,420
Average	-------	4,970	1,350	4,638	4,230	3,573	3,135	1,873	4,917	1,937	3,173	2,178	3,998	3,413	1,750	3,224
Fall plowed, manured:																
Kafir	1	5,310	1,100	4,000	4,040	4,090	0	2,150	5,130	1,390	3,540	3,900	5,280	3,820	2,250	3,286
Oats	1	5,420	2,250	5,010	5,040	5,030	0	1,900	5,960	2,500	3,350	2,830	4,290	2,090	1,700	3,384
Average	-------	5,365	1,675	4,505	4,540	4,560	0	2,025	5,545	1,945	3,445	3,365	4,785	2,955	1,975	3,335
Fall plowed, subsoiled:																
Kafir	1	5,020	1,150	4,760	4,600	3,450	3,330	1,870	5,380	1,670	2,570	2,730	4,070	3,190	1,750	3,253
Spring plowed:																
Kafir	2	4,810	1,350	3,670	4,150	2,480	2,820	1,845	4,405	1,280	2,825	2,310	3,615	3,300	1,450	2,879
Cotton	3	2,965	1,375	4,435	5,103	3,937	2,697	2,267	5,093	1,003	3,477	1,693	3,837	3,390	983	3,018
Milo [2]	1	-------	-------	4,030	3,540	2,830	3,730	1,440	4,060	1,660	6,170	1,400	6,100	2,830	600	[1] 3,199
Cowpeas	4	-------	-------	4,210	3,958	2,903	813	1,550	4,520	2,415	2,985	1,140	3,895	3,695	1,600	[1] 2,807
Average	-------	3,888	1,363	4,086	4,188	3,038	2,515	1,776	4,520	1,590	3,864	1,636	4,362	3,304	1,158	2,949
Spring plowed, top-dressed:																
Kafir	1	4,870	1,900	4,540	4,400	5,600	3,890	2,460	5,160	3,140	3,520	3,780	7,320	3,800	2,750	4,081
Listed:																
Kafir	9	3,436	906	3,063	3,349	2,606	752	2,413	3,796	1,991	2,453	1,958	2,936	3,202	1,528	2,456
Cotton	1	-------	-------	-------	3,445	2,400	2,150	2,000	4,770	1,110	2,820	2,920	4,100	3,220	2,450	[3] 2,853
Average	-------	3,436	906	3,063	3,397	2,503	1,451	2,207	4,283	1,551	2,637	2,439	3,518	3,211	1,989	2,614
Listed, manured:																
Kafir	1	4,520	700	3,200	4,000	3,810	1,090	2,540	4,290	2,250	2,650	3,070	3,340	3,200	2,250	2,922
Fallowed	3	5,310	3,100	4,285	4,440	3,607	1,110	1,940	4,615	2,845	3,255	2,425	4,675	3,810	2,175	3,399

[1] 12-year average.

[2] Milo replaced by feterita beginning with 1925.

[3] 11-year average.

TABLE 8.—*Acre yields of kafir continuously cropped on different methods of listing at the Lawton field station, 1917–1930*

GRAIN (bushels)

Plot	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
A	12.7	0	24.7	28.3	17.9	0	7.5	24.7	14.8	23.3	17.5	27.3	15.8	0	15.3
B	14.0	0	22.3	27.5	22.5	0	5.5	22.2	12.7	23.3	17.3	24.7	17.5	0	15.0
C	12.2	0	24.2	24.3	17.5	0	6.2	20.7	14.7	21.3	12.7	25.7	15.0	0	13.9
D	14.0	0	24.3	23.2	15.8	0	7.8	22.2	9.3	22.2	9.5	20.7	12.0	0	12.9
E	16.5	0	30.5	32.3	16.8	0	10.2	25.2	14.2	24.3	19.2	24.0	12.3	0	16.1
F	16.0	0	28.5	29.7	22.7	2.3	5.7	23.2	13.0	21.3	16.5	26.8	12.0	0	15.6
G	16.5	0	29.8	26.5	21.7	2.0	7.0	24.7	11.8	22.5	14.3	28.7	20.3	0	16.1
H	17.8	0	25.8	22.5	30.7	2.7	11.0	31.0	15.0	25.8	21.3	29.3	29.2	0	18.7
Average	15.0	0	26.3	26.8	20.7	.9	7.6	24.2	13.2	23.0	16.0	25.9	16.8	0	15.5

STOVER (pounds)

A	4,070	800	2,970	3,000	2,550	0	2,400	3,720	2,210	2,760	1,700	3,160	2,800	1,550	2,406
B	3,500	900	2,710	2,700	2,900	0	2,020	3,570	1,990	2,540	1,760	2,720	2,900	1,700	2,279
C	2,790	750	2,800	3,040	2,450	0	2,180	3,360	1,970	2,350	1,490	2,760	2,650	1,350	2,139
D	3,410	800	3,040	3,060	2,175	0	1,980	3,520	1,390	2,630	1,630	2,510	2,380	1,350	2,134
E	3,170	1,050	3,620	3,710	2,690	0	2,450	4,090	1,950	2,240	2,050	2,810	3,710	1,700	2,517
F	4,430	700	3,240	3,020	2,690	860	2,110	3,910	1,970	2,620	1,810	3,140	3,330	1,650	2,534
G	3,980	1,000	3,560	4,110	2,825	380	2,180	3,720	1,790	2,650	1,740	3,280	3,480	1,650	2,596
H	4,520	700	3,200	4,000	3,810	1,090	2,540	4,200	2,250	2,650	3,070	3,340	3,200	2,250	2,922
Average	3,734	838	3,143	3,330	2,761	291	2,233	3,773	1,940	2,555	1,906	2,965	3,056	1,650	2,441

Summer fallow did not show any advantage in the production of kafir during the 14 years that it was tested.

The average yields of kafir under different methods of tillage and crop sequence during the 14 years from 1917 to 1930 are shown graphically in Figure 1.

In Table 8 are shown the results with kafir grown under eight different methods of listing for the 14 years from 1917 to 1930. The methods employed on the eight plots were as follows:

Plot A.—Fall disk, winter list, level in spring, lister plant in same furrows.
Plot B.—Fall list, level in winter, lister plant in same furrows.
Plot C.—Fall list, level in spring, lister plant in same furrows.
Plot D.—Fall list, harrow in the spring, plant by splitting the ridges.
Plot E.—Fall list, plant by splitting the ridges.
Plot F.—Early spring list, cultivate to keep clean until planting time, plant in the same furrows.
Plot G.—Early spring list, plant by splitting the ridges.
Plot H.—Fall disk, manure, winter list, level in the spring, lister plant in the same furrows.

The spread in the 14-year averages, excepting plot H, is not wide, averaging only 3.2 bushels to the acre between plot D and plots E and G. The highest average acre yield obtained for the 14-year period was 18.7 bushels on plot H where manure was applied. Plot D produced the lowest average yield, 12.9 bushels to the acre.

Chinch bugs have always been a damaging factor in this experiment, and if it were possible to eliminate that factor completely the results might well be subject to an entirely different interpretation. This statement applies as well to any experiment that includes kafir in a rotation or any other system of cropping.

RESULTS WITH SORGO

Sorgo has been grown in rows continuously for a period of 14 years on a series of plots under different methods of tillage. Sumac, which is a dependable variety, has been used throughout the test. Chinch bugs frequently inflict serious damage, and after a few years' experience it seemed expedient to plant the crop as early in the spring as practicable. By doing so it is often possible to get the growing crop into a well-advanced, vigorous condition before a heavy infestation of chinch bugs. Planting is usually done from about April 15 to early in May. When the growing plants are approximately 6 inches in height they are uniformly thinned by hand to 6 inches apart in the row.

TABLE 9.—*Acre yields of sorgo grown by different methods at the Lawton field station, 1917–1930*

GRAIN (bushels)

Treatment	Previous crop	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
Spring plowed	Sorgo	15.7	0	29.8	24.3	22.0	[1] 0.0	7.7	15.4	2.0	13.9	15.4	20.0	18.2	0	13.2
Spring plowed, top-dressed	do	17.3	0	32.3	47.0	41.1	3.6	9.1	24.5	15.4	13 8	41.3	33.2	38.8	0	22.7
Fall plowed	do	16.8	0	27.0	24.5	29.1	[1] 0	8.9	15.2	6.4	14.3	26.4	18.9	19.1	0	14.8
Fall plowed, subsoiled	do	16.3	0	32.5	27.0	28.9	5.0	7.3	17.5	6.4	16.1	18.2	31.4	25.7	0	16.7
Listed [2]	do	7.1	0	23.2	31.3	12.9	4.6	5.4	16.1	11.3	20.4	18.2	23.4	15.0	0	13.5
Disked, listed [3]	do	21.3	0	32.9	32.0	24.1	3.0	6.8	17.5	11.6	22.3	15.2	25.7	13.4	0	16.1
Average of listing		14.2	0	28.1	31.7	18.5	3.8	6.1	16.8	11.5	21.4	16.7	24.6	14.2	0	14.8
Fallowed		18.9	0	36.4	24.6	28.9	[1] 0	8.4	17.1	14.6	18.4	26.4	31.6	29.1	0	18.2

STOVER (pounds)

Treatment	Previous crop	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
Spring plowed	Sorgo	8,190	1,150	9,080	10,140	4,820	[1] 0	4,220	7,340	1,550	5,870	2,740	6,880	4,030	1,500	4,825
Spring plowed, top-dressed	do	11,280	1,050	10,540	15,820	7,050	11,860	4,400	10,130	4,040	6,980	7,640	9,540	7,630	4,300	8,025
Fall plowed	do	8,620	900	8,800	10,080	5,770	[1] 0	4,300	7,050	1,540	5,850	4,880	6,190	4,130	1,450	4,975
Fall plowed, subsoiled	do	8,060	730	8,930	10,990	5,780	5,000	3,590	7,320	2,340	6,050	3,130	5,740	7,560	2,250	5,534
Listed [2]	do	5,950	1,550	6,650	7,900	2,580	5,540	3,050	5,250	2,820	6,190	3,330	9,240	5,860	2,450	4,881
Disked, listed [3]	do	8,580	1,050	8,260	9,510	5,300	5,680	3,870	5,170	2,500	6,150	2,700	7,710	7,800	2,750	5,502
Average of listing		7,265	1,300	7,455	8,705	3,940	5,610	3,460	5,210	2,660	6,155	3,015	8,475	6,830	2,600	5,191
Fallowed		8,610	5,200	9,910	9,020	5,680	[1] 0	4,130	7,940	3,580	6,070	4,880	9,180	8,170	2,900	6,134

[1] Failure due to chinch bugs. [2] Beginning with 1921 the land was disked and listed deep. [3] Beginning with 1921 the land was disked and listed shallow

The results of the experiment are given in Table 9. There is little difference in the yields on spring plowing and on fall plowing, but where spring plowing was top-dressed with manure the average grain yield was 8.7 bushels to the acre more than the average of spring plowing and fall plowing without manure. The yield of stover was likewise increased 3,125 pounds to the acre.

Subsoiling did not show any appreciable effect.

The treatment of the two listed plots, F and G, was the same as has been described for similarly designated plots of kafir. From 1917 to 1920, inclusive, the yearly yields of grain were less on plot F than on plot G, except in 1918, when failures were recorded on both plots. The yearly production of stover was likewise less on plot F with one exception. For the 10-year period 1921 to 1930 the average yield of grain on plot G was only 1.3 bushels to the acre more than on plot F. The average yields of stover on these two plots for the same period differ by only 335 pounds to the acre in favor of plot G. The 14-year average of both methods of listing differs but little from the average of spring plowing and fall plowing. The largest average yield of stover for the 14 years, produced on plot G, was 677 pounds to the acre more than the lowest average yield, produced on spring plowing. On summer-fallowed land the yield of grain was 4.5 bushels and of stover 1,891 pounds to the acre less than on continuously cropped land that was spring plowed and top-dressed with manure.

Sorgo has proved to be a dependable crop, and may be relied upon to produce satisfactory yields of forage as roughage for livestock.

RESULTS WITH FETERITA

Feterita is a catch crop that may be sown early in the spring for early feed, or may be sown late in the season as soil-moisture conditions warrant and the feed requirements demand. The crop is more susceptible to injury by chinch bugs than either kafir or sorgo, and its chances of normal growth and development are uncertain. The introduction of Spur feterita in recent years has been of considerable benefit because it is more resistant to chinch-bug damage than is common feterita.

As shown in Table 10, the results of three methods of production for 14 years are available. The difference in average yields between spring plowing and fall plowing continuously cropped to feterita amounted to 2.2 bushels to the acre in favor of fall plowing. Summer-fallowed land proved of no advantage to the production of the crop.

Beginning with 1924, feterita was substituted for milo in a number of rotations, and from then on data from six additional methods are available. In these rotations fall plowing was 2.9 bushels to the acre more productive than spring plowing. There was but little difference in the yields following kafir, cotton, or cowpeas on the spring plowing. On fall plowing, where feterita followed kafir and cowpeas, the difference in yields was also negligible, but in both instances the yields exceed those on spring plowing under the same crop sequence. A still further increase in yield followed when cowpeas were plowed under for green manure instead of being harvested for hay.

TABLE 10.—*Acre yields of feterita grown by different methods at the Lawton field station, 1917–1930*

GRAIN (bushels)

Treatment and previous crop	Plots averaged	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average 1917–1930	Average 1924–1930
Spring plowed:																	
Feterita	1	21.4	0	28.1	21.4	5.2	0	7.6	25.3	2.9	18.1	21.4	22.9	17.9	2.8	13.9	15.9
Kafir	1								20.7	4.3	12.8	14.8	26.9	21.0	3.3		14.8
Cowpeas	1								22.8	8.3	12.9	0	21.0	24.7	3.1		13.3
Cotton	1								23.3	5.9	9.1	6.6	17.9	28.6	0		13.1
Fall plowed:																	
Feterita	1	25.2	0	29.8	26.2	13.1	0	10.3	26.9	5.3	20.5	25.0	19.7	20.0	4.0	16.1	17.3
Kafir	2								24.5	4.7	16.0	9.6	26.4	27.7	5.4		16.3
Cowpeas	1								23.6	13.6	12.8	4.3	25.9	30.2	8.1		16.9
Fallowed	1	22.6	0	33.6	20.7	7.9	0	11.4	24.6	10.8	17.0	12.8	29.8	26.1	5.7	15.9	18.1
Green manured:																	
Cowpeas	1								29.8	6.2	19.1	21.7	36.4	31.4	6.0		21.5

STOVER (pounds)

Treatment and previous crop	Plots averaged	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average 1917–1930	Average 1924–1930
Spring plowed:																	
Feterita	1	2,760	1,700	3,620	3,110	1,300	0	1,360	2,630	430	1,300	2,410	4,170	3,210	440	2,031	2,084
Kafir	1								3,100	750	1,360	1,790	4,990	4,080	960		2,433
Cowpeas	1								2,580	1,170	1,900	0	4,030	3,670	270		1,946
Cotton	1								2,700	1,060	1,120	3,700	3,960	4,540	1,050		2,590
Fall plowed:																	
Feterita	1	4,570	1,500	4,670	3,080	2,490	0	1,900	2,940	390	1,460	2,460	4,310	4,440	520	2,481	2,360
Kafir	2								2,755	830	1,675	970	5,220	4,120	1,115		2,384
Cowpeas	1								2,680	2,210	1,860	600	4,950	4,750	1,680		2,676
Fallowed	1	3,710	2,050	3,450	2,950	2,190	0	1,340	2,915	1,700	1,690	1,410	5,300	3,985	1,195	2,420	2,599
Green manured:																	
Cowpeas	1								2,870	890	1,840	2,150	6,090	3,980	950		2,681

RESULTS WITH MILO

Milo was grown from 1917 to 1923, inclusive. During this 7-year period grain was produced by all methods in three years only, 1917, 1919, and 1920. As shown in Table 11, creditable yields were produced in only two of these years. Total failures were recorded in three of the remaining years of the period and on all but one plot in a fourth year. Of all the grain sorghums, milo is the most susceptible to the chinch bug. In southwestern Oklahoma this insect is the chief inhibiting factor in the production of the crop. This fact is widely recognized, and the acreage devoted to milo is negligible. West and northwest of Lawton, especially near the Oklahoma-Texas line, the acreage and production become considerable.

TABLE 11.—*Acre yields (in bushels) of milo grown by different methods at the Lawton field station, 1917–1923*

Previous crop and treatment	1917	1918	1919	1920	1921	1922	1923	Average
Milo:								
Spring plowed	10.9	0	46.6	31.2	0	0	0	12.7
Spring plowed, top-dressed	9.7	0	48.6	27.1	26.6	0	0	16.0
Fall plowed	8.8	0	50.5	35.9	0	0	0	13.6
Fall plowed, subsoiled	12.6	0	48.6	28.3	0	0	0	12.8
Listed	12.4	0	34.9	16.8	0	0	0	9.2
Cowpeas:								
Green manured	1.0	0	50.5	42.1	0	0	0	13.4
Fallowed	13.6	0	55.3	30.9	0	0	0	14.3

RESULTS WITH CORN, KAFIR, SORGO, AND FETERITA UNDER CONTINUOUS CROPPING

The discussion thus far has involved only such crops as are grown primarily for local consumption, and all rotations and cultural methods used have been included. The results with corn, kafir, sorgo, and feterita, grown for a 14-year period under a system of continuous cropping by different methods of tillage, are summarized in Table 12 and Figure 2. Although there is but little difference between the grain yields of corn and kafir, the quality of the corn was almost always inferior to that of kafir, and the shelling percentage of the corn usually was low. The likelihood of producing at least some grain is also greater with kafir than with corn. Sorgo ranks third in comparison with corn and kafir in the quantity of grain produced and first of all four crops in the production of forage, which constitutes its chief value. In total crop yield sorgo averaged 2,209 pounds per acre more than kafir, 3,407 pounds more than corn, and 2,953 pounds more than feterita grown under comparable methods. Feterita averaged higher in grain production than sorgo and higher in total crop than corn for the three comparable methods of production.

TABLE 12.—*Average acre yields (in pounds) of corn, kafir, sorgo, and feterita on fallow and continuously cropped by different methods of seed-bed preparation at the Lawton field station, 1917–1930*

Tillage	Grain				Total crop			
	Corn	Kafir	Sorgo	Feterita	Corn	Kafir	Sorgo	Feterita
Spring plowed	1,090	1,159	737	808	2,855	3,960	5,562	2,839
Spring plowed, top-dressed	1,491	1,016	1,269	.....	4,184	5,097	9,294	.....
Fall plowed	1,116	1,336	826	930	2,906	4,542	5,801	3,417
Fall plowed, subsoiled	1,436	1,300	933	.....	3,642	4,553	6,466	.....
Listed	1,121	866	829	.....	2,820	3,616	6,020	.....
Fallowed	1,474	1,514	1,040	964	3,334	5,323	7,210	3,459
Average	1,289	1,199	939	903	3,319	4,517	6,726	3,238

The total crop produced was somewhat higher on fall plowing than on spring plowing for all crops. Listing proved to be the poorest method of seed-bed preparation for corn and kafir, but it was slightly better for sorgo than either spring plowing or fall plowing. The gain, however, was too small to be of much significance.

Subsoiling as compared with fall plowing showed a small gain for corn in both grain and total quantity of crop. The difference in yields between the two methods for kafir was negligible. Although subsoiling for sorgo showed an increase of 665 pounds of total crop and 107 pounds of grain to the acre over fall plowing, the difference was not great enough to compensate for the extra tillage.

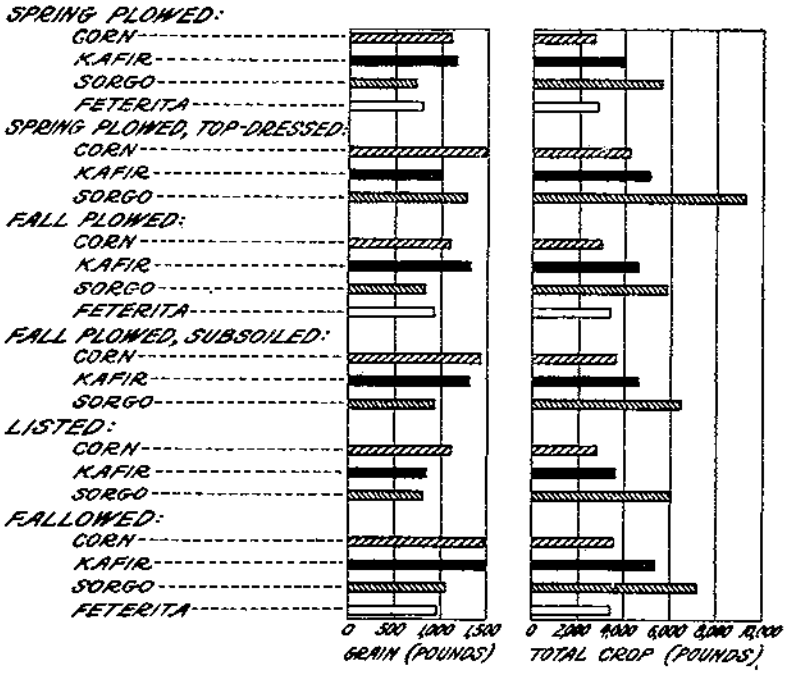

FIGURE 2.—Average yields of corn, kafir, sorgo, and feterita on fallow and continuously cropped by different methods of seed-bed preparation at the Lawton field station for the 14 years 1917–1930

Sorgo on land plowed in the spring yielded 532 pounds of grain and 3,732 pounds of total crop to the acre more when top-dressed with manure than when it was not. Top-dressing was also of distinct advantage as compared with each of the other methods shown. Corn showed a smaller gain from the use of manure, and kafir showed a definite loss in grain yields but an increase in the total crop.

Fallow was not of sufficient advantage with any crop to warrant the practice. Water can not be stored in satisfactory quantities in the soil on which these crops were grown. Insect injury or severe climatic conditions or a combination of both during the growing season may quickly overcome the benefit derived from available moisture stored in the soil.

RESULTS WITH BROOMCORN

During the 14 years from 1917 to 1930, in which tillage experiments have been carried on with broomcorn, three entire failures have been recorded. Drought was the factor responsible for a complete failure in 1918, but the complete failures in 1925 and in 1927 and the partial failures in 1921, 1922, and 1930, were due principally to chinch-bug injury.

Broomcorn is strictly a cash crop, but the stover remaining in the field after the brush is removed is often pastured for a short time. Table 13 shows the results of continuous cropping to broomcorn with different cultural methods from 1917 to 1930, inclusive. Chinch-bug injury has been so prevalent throughout the entire period of this experiment that a quantitative study of the results presented is scarcely justified. The yields of two plots located almost side by side have ranged from 0 to 770 pounds of brush to the acre, with the difference due to the entire destruction of the crop on one plot by chinch bugs. In 1919, 1924, 1926, and 1928, when climatic conditions were favorable to production and chinch-bug infestation and injury were less severe, the fluctuation in yields resulting from different tillage methods was rather small. Broomcorn is grown over a considerable area in the western part of Oklahoma, but the acreage is chiefly confined to sandy soil, where the crop is grown with more certainty than on heavy soils.

TABLE 13.—*Acre yields (in pounds) of broomcorn grown by different methods of tillage at the Lawton field station, 1917-1930*

Previous crop and treatment	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
Broomcorn:															
Spring plowed	370	0	750	440	0	0	223	460	0	420	0	660	150	0	248
Spring plowed, top-dressed	400	0	650	770	770	250	370	510	0	600	0	830	730	280	440
Fall plowed	370	0	850	590	450	0	150	450	0	460	0	570	210	0	293
Fall plowed, subsoiled	330	0	750	580	700	0	260	410	0	410	0	640	300	0	313
Listed, no other preparation [1]	290	0	600	450	0	0	156	340	0	450	0	560	220	0	219
Disked, listed [2]	280	0	500	470	650	210	157	480	0	360	0	560	320	0	285
Average	285	0	550	460	325	105	157	410	0	405	0	560	270	0	252
Fallowed	280	0	650	610	700	0	183	460	0	440	0	590	260	0	208

[1] Beginning with 1921 the land was disked and listed deep.
[2] Beginning with 1921 the land was disked and listed shallow.

RESULTS WITH COTTON

Cotton occupied an important place in the rotation and tillage experiments at the Lawton station during the 14 years from 1917 to 1930. It is well adapted to an elastic system of crop rotations that may necessarily be changed by the individual farmer to meet the fluctuating conditions of climate and other crop hazards. Greater dependence is placed upon it than upon any other crop as a source of income in southwestern Oklahoma. The crop endures the hot, dry summers well, and in the vicinity of Lawton it has only once suffered severely from insect damage.

TABLE 14.—*Acre yields (in pounds) of cotton lint and seed cotton grown by different methods at the Lawton field station, 1917–1930*

LINT

Treatment and previous crop	Plots averaged [1]	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average 1917–1930	Average 1920–1930
Spring plowed:																	
Cotton	1	220	0	360	446	150	110	90	300	190	310	470	170	180	40	217	223
Corn	1	------	------	------	423	140	145	89	410	240	210	540	220	220	60	------	245
Peanuts	1	------	------	------	427	160	130	110	370	280	340	450	250	230	50	------	254
Cowpeas	1	------	------	------	403	130	155	90	360	330	300	440	240	210	70	------	248
Wheat	2	------	------	------	------	------	------	100	260	170	236	475	170	225	50	------	[2] 210
Average	------	220	0	360	425	145	135	96	340	242	278	475	210	213	54	228	238
Spring plowed, top-dressed:																	
Cowpeas	1	------	------	------	458	160	200	90	330	320	290	470	240	240	70	------	265
Disked:																	
Cowpeas	2	------	------	------	------	------	------	90	355	235	215	610	230	240	90	------	[2] 258
Fall plowed:																	
Cotton	7	220	0	380	479	170	108	116	291	211	231	536	173	213	56	227	235
Milo [3]	1	360	0	400	434	160	200	120	450	200	410	610	210	240	60	275	281
Wheat	5	275	0	370	336	155	155	------	219	182	234	476	196	220	60	[4] 221	[5] 223
Cowpeas	3	200	0	450	391	127	150	140	400	340	270	610	290	290	80	267	281
Corn	1	------	------	------	------	------	------	220	450	230	230	630	230	290	90	------	[2] 296
Oats	1	------	------	------	427	180	120	160	320	280	270	450	180	230	90	------	246
Sweetclover	2	------	------	------	------	------	145	80	465	165	160	555	180	275	65	------	[6] 232
Sorgo (drilled)	1	------	------	------	------	------	------	100	530	190	290	630	210	300	50	------	[2] 288
Average	------	264	0	400	413	158	146	134	391	225	262	562	209	257	69	249	257
Fall plowed, top-dressed:																	
Wheat	1	------	------	------	------	------	------	------	250	170	220	500	200	220	40	------	[7] 229
Fall plowed, subsoiled:																	
Cotton	1	240	0	350	451	130	150	130	320	280	290	520	210	220	80	241	253
Fall plowed, spring listed:																	
Cotton	1	200	0	310	522	170	150	120	280	220	320	510	220	190	50	223	250
Listed:																	
Cotton	2	160	0	250	297	80	90	85	215	165	305	360	135	150	40	167	175
Green manured:																	
Cowpeas	2	------	------	------	435	150	200	110	320	310	265	490	250	220	75	------	257
Fallowed	2	250	0	350	314	135	165	135	310	235	345	510	235	255	70	239	249
Fallowed, manured	1	------	------	------	280	170	200	170	390	380	330	550	260	310	100	------	285
Fallowed, top-dressed	1	------	------	------	223	160	140	110	350	270	210	520	230	240	90	------	231

SEED COTTON

Spring plowed:																	
Cotton	1	600	0	1,020	1,230	410	310	260	780	460	860	1,180	460	470	110	582	594
Corn	1				1,185	390	415	255	1,080	590	550	1,430	590	610	180		661
Peanuts	1				1,205	450	380	310	980	670	860	1,170	670	590	130		674
Cowpeas	1				1,122	385	450	260	950	810	730	1,130	630	550	190		655
Wheat	2							280	690	415	530	1,210	460	575	115		[2] 534
Average		600	0	1,020	1,186	409	389	273	896	589	706	1,224	562	559	145	611	631
Spring plowed, top-dressed:																	
Cowpeas	1				1,305	460	580	250	1,000	820	740	1,210	660	600	180		710
Disked:																	
Cowpeas	2							245	930	605	585	1,550	600	625	225		[2] 671
Fall plowed:																	
Cotton	7	610	0	1,100	1,339	478	308	321	760	539	623	1,359	486	564	147	617	629
Milo [3]	1	990	0	1,150	1,228	460	590	330	1,180	510	1,120	1,320	560	630	180	753	764
Wheat	5	770	0	1,050	1,000	465	425		574	428	594	1,208	532	560	164	[4] 598	[5] 595
Cowpeas	3	550	0	1,310	1,106	370	417	400	1,050	840	720	1,630	770	760	210	724	752
Corn	1							600	1,170	590	640	1,620	610	750	240		[2] 778
Oats	1				1,200	510	340	430	830	670	680	1,180	490	590	210		648
Sweetclover	2						405	220	1,215	440	420	1,415	510	730	185		[6] 616
Sorgo (drilled)	1							300	1,390	490	800	1,640	590	820	130		[2] 770
Average		730	0	1,153	1,175	457	414	372	1,021	563	700	1,459	569	676	183	677	690
Fall plowed, top-dressed:																	
Wheat	1								660	450	550	1,270	540	560	110		[7] 591
Fall plowed, subsoiled:																	
Cotton	1	670	0	980	1,265	360	420	330	850	650	800	1,330	570	580	220	645	670
Fall plowed, spring listed:																	
Cotton	1	560	0	890	1,400	470	400	330	720	500	830	1,280	590	490	140	618	655
Listed:																	
Cotton	2	450	0	715	820	240	255	250	565	390	825	915	365	355	125	448	464
Green manured:																	
Cowpeas	2				1,243	420	580	320	835	805	665	1,305	675	575	195		693
Fallowed	2	690	0	1,020	880	390	465	375	805	680	890	1,305	640	680	190	642	602
Fallowed, manured	1				785	490	570	490	1,020	990	820	1,450	720	810	260		764
Fallowed, top-dressed	1				625	480	410	320	920	690	540	1,360	650	620	240		623

[1] Not all continuous for entire period.
[2] 8-year average.
[3] Milo replaced by feterita beginning 1924.
[4] 13-year average.
[5] 10-year average.
[6] 9-year average.
[7] 7-year average.

In 1924 grasshoppers ravaged the cotton seriously and in many instances disastrously, and vigorous and persistent protective measures were necessary to save the crop. The cotton-leaf worm, the bollworm, and the webworm frequently are present during parts of the growing season and are sometimes responsible for more or less local damage.

The 14 years' results with cotton at the Lawton station are presented in Table 14 and Figure 3.

Only one entire failure was recorded in the 14 years, and that was in 1918, when all the other crops grown at the station failed or were very poor.

Where cotton followed cotton the time of plowing had a negligible influence on the 14-year average of lint. The differences between the annual yields of lint were always small, except in 1926, when spring plowing produced 79 pounds of lint to the acre more than fall plowing, and in 1927, when fall plowing produced 66 pounds of lint to the acre more than spring plowing.

The yields of cotton following corn, drilled sorgo, milo, and feterita were relatively high, but this may be partly due to the favorable location of the rotations containing these crops.

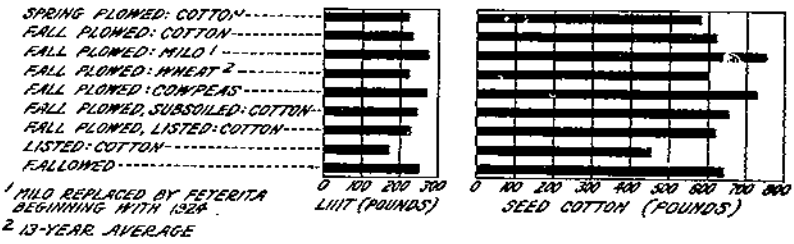

FIGURE 3.—Average acre yields of cotton grown by different methods at the Lawton field station for the 14 years 1917–1930

Cotton appears to do particularly well after cowpeas. On fall plowing it averaged, for the 14 years, 40 pounds more lint to the acre following cowpeas than following cotton. Fall plowing wheatland as a method of preparation for cotton proved to be satisfactory during the 13 years that it was tried. Subsoiling did not show a marked advantage. If the cost of production were taken into account, this method would not be at all feasible.

Lister planting without previous cultivation gave the poorest results of any method tried. The average yield of 167 pounds of lint to the acre was 50 pounds less than the yield from continuous cropping on spring-plowed land and 60 pounds less than that of cotton following cotton on fall plowing. As compared with the average of all fall plowing, listing showed a loss of 82 pounds of lint to the acre. If the average yield of cotton after milo is eliminated from the average of all fall plowing, listing still shows a loss of 71 pounds of lint to the acre. When the land was plowed in the fall and lister planted in the spring there was a gain of 66 pounds of lint to the acre over lister planting without other preparation. The yields by this method were slightly better than those from surface planting on either fall or spring plowing.

Fallow has been of no benefit whatever to cotton, even in years when the production under all other methods was low. In many instances yields from continuous cropping or following other crops equaled or exceeded the yields obtained on fallow.

Beginning with 1920 and 1923, a greater number of crop arrangements and systems of crop sequence than in previous years were available for study, as shown in Table 14.

In several instances these show considerable differences in the yields of cotton due to the time of plowing, the average results being in favor of plowing in the fall. Cotton grown on cowpea land under five methods of tillage from 1923 to 1930, inclusive, produced the following yields of lint in pounds to the acre: Disked, 258; spring plowed, 255; spring plowed and top-dressed, 263; fall plowed, 303; and green manured, 255. When corn was the previous crop during the eight years 1923 to 1930, inclusive, there was a difference of 47 pounds of lint to the acre in favor of fall plowing. On fall-plowed land previously cropped to wheat or oats the greater yield was obtained following oats. On fall-plowed sweetclover land, from 1922 to 1930, inclusive, cotton produced a yield about average as compared with the yield under other methods. The sweetclover, however, frequently failed to make a good stand in the spring or died during the droughty periods in the summer. Weeds and crabgrass usually supplant sweetclover under such conditions, and the succeeding crop of cotton requires considerable extra tillage. A high average yield was produced on spring-plowed peanut land, but little importance should be attached to this method, as the tight upland is not adapted to the production of peanuts. Furthermore, peanuts were destroyed by rabbits in 1925, 1926, 1927, and 1930. In 1928 the seed failed to germinate, and a late planting of cowpeas was substituted, as was also done in 1930. In 1922 the peanut crop was a failure.

A top-dressing of manure applied to spring-plowed cowpea land increased the yield of lint 17 pounds to the acre. Using cowpeas as a green-manure crop for cotton did not prove worth while. The average acre yield of lint for 11 years on manured fallow was 36 pounds higher than on ordinary fallow and 54 pounds higher than on fallow top-dressed with manure.

RESULTS WITH WHEAT

Wheat has been grown under a wide range of methods during the 14 years from 1917 to 1930. A satisfactory combination and arrangement of wheat with other crops has been difficult. This was due to the disastrous results caused by heavy migration of chinch bugs, usually present in the wheat, to adjoining row crops. In order to alleviate this condition as much as possible, it became necessary to revise many of the rotations and to change others to new locations. This action necessarily broke the continuity of many of the experiments, terminated others, and made possible the addition of new experiments. Table 15 shows that wheat yields are subject to wide fluctuations from year to year regardless of the methods employed in production. In 1918 the yields ranged from 0 to 9.2 bushels per acre and in 1922 from 0 to 6.5 bushels, with no single method outstanding in avoiding inconsequential yields. On the other hand, in 1924 the lowest acre yield recorded was 32.8 bushels and the highest 46 bushels.

TABLE 15.—*Acre yields (in bushels) of wheat grown by different methods at the Lawton field station, 1917–1930*

Treatment and previous crop	Plots averaged [1]	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average			
																1917–1930	1917–1922	1920–1930	1924–1930
Late plowed: Wheat	1	5.8	0	24.3	26.3	12.7	1.5	-------	40.3	3.3	23.2	17.3	11.8	9.8	6.7	[2] 14.1	11.8	[3] 15.3	16.1
Early plowed: Wheat	5	11.2	2.7	27.7	22.8	13.8	2.7	-------	37.1	3.8	28.5	16.0	15.5	9.7	6.4	[2] 15.2	13.5	[3] 15.6	16.7
Early plowed, subsoiled: Wheat	1	13.3	3.3	25.7	26.2	12.5	1.7	-------	33.2	3.3	27.5	17.5	16.3	9.5	6.0	[2] 15.1	13.8	[3] 15.4	16.2
Average	-------	10.1	2.0	25.9	25.1	13.0	2.0	-------	36.9	3.5	26.4	16.9	14.5	9.7	6.4	[2] 14.8	13.0	[3] 15.4	16.3
Listed: Wheat	2	14.9	2.2	24.0	21.4	14.8	2.5	-------	43.0	5.5	25.0	17.7	15.5	8.3	4.3	[2] 15.3	13.3	[3] 15.8	17.0
Listed, manured: Wheat	1	20.6	0	17.2	26.7	11.5	0	-------	46.0	4.0	27.7	10.3	8.7	6.2	2.5	[2] 14.0	12.7	[3] 14.4	15.1
Fallowed	3	16.6	5.6	27.7	24.4	15.6	3.3	22.0	42.0	12.0	27.0	15.2	25.5	15.7	9.5	18.7	15.5	19.3	21.0
Fallowed, top-dressed	2	23.0	9.2	25.7	17.4	14.6	4.3	33.7	45.0	15.0	25.8	15.2	26.3	24.2	6.2	20.4	15.7	20.7	22.5
Fallowed, manured	1	-------	-------	-------	18.8	18.3	3.7	30.7	46.0	13.2	28.0	13.5	27.5	22.3	6.3	-------	-------	20.8	22.4
Disked: Corn	7	14.8	2.7	23.7	27.1	14.8	1.5	-------	-------	-------	-------	-------	-------	-------	-------	-------	14.1	-------	-------
Fall plowed: Oats	2	-------	-------	-------	17.0	16.5	4.3	17.3	39.5	2.3	27.6	14.2	19.4	9.3	7.0	-------	-------	15.9	17.0
Disked: Cowpeas	4	-------	-------	31.1	20.5	12.6	6.3	19.4	41.0	8.9	26.4	11.5	19.3	11.8	7.0	-------	-------	16.8	18.0
Disked, top-dressed: Cowpeas	1	-------	-------	-------	14.0	15.3	6.5	20.8	40.5	9.5	26.7	13.2	18.2	15.7	5.8	-------	-------	16.9	18.5
Green manured: Cowpeas	2	-------	-------	-------	17.0	13.2	2.8	24.3	44.3	9.1	28.2	11.9	23.5	13.9	8.2	-------	-------	17.9	19.9
Drilled: Cotton	6	-------	-------	-------	19.0	14.0	-------	17.1	32.8	3.6	22.9	10.4	15.6	9.4	2.3	-------	-------	[3] 14.7	13.9
Drilled, top-dressed: Cotton	1	-------	-------	-------	-------	-------	-------	18.3	33.2	6.5	20.7	9.3	11.7	9.8	3.3	-------	-------	-------	13.5
Plowed: Spring barley	1	-------	-------	-------	-------	-------	-------	-------	38.3	3.5	22.2	14.5	18.3	9.5	7.8	-------	-------	-------	16.3
Early disked: Wheat	1	-------	-------	-------	-------	-------	-------	-------	40.2	2.5	26.3	15.8	15.5	8.3	5.7	-------	-------	-------	16.3
Late disked: Wheat	1	-------	-------	-------	-------	-------	-------	-------	34.2	3.8	19.5	11.5	10.2	5.2	3.8	-------	-------	-------	12.6
Disked as needed: Wheat	1	-------	-------	-------	-------	-------	-------	-------	34.3	5.7	22.8	15.3	14.0	4.8	5.0	-------	-------	-------	14.6

[1] Greatest number at one time. Not continuous for entire period.

[2] 13-year average.

[3] 10-year average.

The average acre yield from all methods was 3.2 bushels in 1918 and 39.5 bushels in 1924. With such wide variations in yields, it is essential that results should cover a long period to be of definite value. The apparent advantage or disadvantage of one method of production as compared with another is of little importance if the results cover only a few years, because even wide differences shown in a short period may be eliminated or reversed in a longer period.

The difference in average yields, for 13 years, of wheat following wheat on late plowing, early plowing, subsoiling, listing, and manured listing was only 1.3 bushels to the acre. Early plowing, listing, and subsoiling were done from July 11 to August 13, usually about the middle of July. Early plowing was done to a depth of 7 to 8 inches. Late plowing was done to a depth of 4 inches from September 19 to October 15, but usually the latter part of September. Manure applied to wheat on listed land produced a rapid and increased growth of straw, but had little effect on the average yield of grain. The average yield of wheat on fallow and top-dressed fallow from 1917 to 1930, inclusive, was only 3.9 and 5.6 bushels to the acre, respectively, more than the average of wheat after wheat on the several methods of fall plowing and subsoiling.

During the years 1917 to 1922, inclusive, early plowing, subsoiling, manuring, and listing had a distinct advantage over late plowing in only one year, 1917. The average acre yield of wheat after wheat on all methods for the six years was 13 bushels, and on disked corn ground for the same period only 14.1 bushels. There was practically no difference in the average acre yields obtained from fallow and top-dressed fallow, and the average of both methods was only 1.5 bushels more than from disked corn ground and 2.6 bushels more than from wheat after wheat.

In the period from 1919 to 1924 the experiments included 10 additional methods of wheat production. Excluding yields from fallow methods, the greatest difference in the average yields during the period 1920–1930 was 3.5 bushels to the acre. The lowest average yield for this period was on listed manured wheatland and the highest was on cowpeas turned under for green manure. The increases obtained on fallow were not enough to make this method practicable. Neither did green manuring prove feasible. When cowpeas are harvested for hay and the land is disked in preparation for wheat, satisfactory yields usually are obtained with a minimum of labor. Although the average yield of wheat drilled on cotton is slightly less than that on disked cowpea land, the method is practicable and adapted to systems of crop diversification.

Methods designed to insure maximum safety in production or those in which cost of production is high did not give satisfactory results. The variations between methods of production in a single year or in a period of years are unimportant as compared with the wide fluctuations to which all methods of production are subject. The results presented indicate that wheat production should be adjusted to suit the individual farm and its equipment. Although a satisfactory average yield over a long period of years may be expected, the large annual fluctuations demand that the production be planned on a thoroughly economical basis that will carry the grower through the years of low yields.

RESULTS WITH OATS

In southwestern Oklahoma oats have always been considered important as a dependable source of early feed for work stock.

In Table 16 the annual and average yields of oats on fall-plowed cotton land and on alfalfa sod may be compared directly for the 14 years from 1917 to 1930. Oats on alfalfa sod are grown in a 6-year rotation that contains three years of alfalfa, one plot being broken in the late summer for the succeeding crop of oats. Oats on fall-plowed cotton are grown in a 4-year rotation of cowpeas, cotton, oats, and kafir. All crops in this rotation are grown on fall or winter plowing with manure disked into oat land in the winter for kafir.

TABLE 16.—*Acre yields (in bushels) of oats, winter barley, and spring barley grown by different methods at the Lawton field station, 1917–1930*

Crop	Treatment and previous crop	1917	1918	1919	1920	1921	1922	1923	1924
Oats	Fall plowed: Alfalfa	6.6	0	15.6	62.8	37.2	54.7	44.7	34.1
Do	Fall plowed: Cotton	5.0	0	12.2	79.7	47.5	42.2	49.1	85.6
Do	Fall plowed: Wheat	------	------	------	53.1	33.4	32.8	55.0	52.5
Do	Disked: Cotton	------	------	------	55.7	28.8	41.1	41.9	68.8
Do	Disked: Wheat	------	------	------	------	------	------	37.2	53.8
Winter barley	Disked: Cowpeas	------	------	------	------	------	------	11.7	69.2
Spring barley	do	------	------	------	------	------	------	8.5	31.3
Do	Disked: Wheat	------	------	------	------	------	------	13.8	22.9

Crop	Treatment and previous crop	1925	1926	1927	1928	1929	1930	Average 1917–1930	Average 1920–1930	Average 1923–1930
Oats	Fall plowed: Alfalfa	17.8	45.9	25.0	45.0	30.9	22.5	31.6	38.2	33.2
Do	Fall plowed: Cotton	19.1	52.2	22.5	36.6	25.0	25.9	35.9	44.1	39.5
Do	Fall plowed: Wheat	22.2	29.1	18.8	32.8	25.3	30.1	------	35.8	34.4
Do	Disked: Cotton	23.1	52.5	18.1	34.7	27.8	44.4	------	39.7	38.9
Do	Disked: Wheat	21.9	33.4	21.3	22.2	24.1	25.9	------	------	30.0
Winter barley	Disked: Cowpeas	0	48.3	29.4	16.7	11.0	4.2	------	------	23.8
Spring barley	do	1.9	21.3	2.5	13.8	12.3	8.3	------	------	12.5
Do	Disked: Wheat	5.4	20.6	3.5	13.1	14.4	7.7	------	------	12.7

Oats grown on fall-plowed cotton land outyielded those grown on alfalfa sod during the 14 years that the two methods were under trial. The 14-year average yield from 1917 to 1930, inclusive, showed a gain of 4.3 bushels to the acre in favor of fall-plowed cotton land. In the 11-year period 1920–1930 and the 8-year period 1923–1930 the gains were 5.9 and 6.3 bushels to the acre, respectively. In a comparison of four methods of production that became available from 1920 to 1930, inclusive, oats on fall-plowed cotton land outyielded all other methods. The average yield on disked cotton land, however, was only 4.4 bushels to the acre less. Oats on fall-plowed wheatland yielded 8.3 bushels to the acre less than on fall-plowed cotton land, and growing the crop in this manner proved to be the poorest of the methods compared. During the eight years from 1923 to 1930, inclusive, one additional method—oats on disked wheatland—was added. Growing oats on cotton land either disked or fall plowed proved to be the best method of production. During this period there was a difference of 9.5 bushels to the acre between the lowest and the highest average yields.

RESULTS WITH BARLEY

Spring barley has been grown only to a very limited extent, because of its apparent inability to give satisfactory results. Winter barley, on the other hand, has gained so rapidly in acreage since 1919 that it is now recognized as an important crop in western Oklahoma. Both winter and spring barley are subject to the menace of crop insects, and their location with respect to grain sorghums, forage sorghums, and corn must necessarily be arranged with considerable care.

Results for eight years are available for winter and spring barley and are presented in Table 16. Spring barley produced a little more than half as much as winter barley during the eight years. The annual yields of winter barley ranged from 0 to 69.2 bushels to the acre, and the annual yields of spring barley ranged from 1.9 to 31.3 bushels to the acre. Spring barley on disked cowpea land and on disked wheatland gave practically the same results for the eight years, and the average of both methods was 11.2 bushels to the acre less than that of winter barley on disked cowpea land.

Winter barley was entirely winterkilled in 1925 and 1930. In 1930 winter barley was reseeded February 14, and a yield of 4.2 bushels to the acre was produced under very unfavorable spring climatic conditions. Both crops usually suffer from severe chinch-bug injury and require climatic conditions that are favorable to early maturity.

COMPARATIVE YIELDS OF WHEAT, OATS, AND BARLEY

In Table 17 are given the number of pounds of grain produced per acre by wheat and oats under two comparable methods for the 11 years 1920–1930, also the quantity of grain produced by wheat, winter barley, and spring barley on disked cowpea land for the 8 years 1923–1930. In 10 comparable years oats produced 148 pounds to the acre more than wheat on fall-plowed wheatland, and in the same number of years the difference on cotton land was 429 pounds to the acre in favor of oats. The cotton land was disked for a spring seeding of oats, and the wheat was sown between the cotton rows with a 1-horse drill. In order to facilitate a uniform seeding, a 1-horse harrow preceded the wheat drill.

TABLE 17.—*Acre yields (in pounds) of wheat and oats following wheat and cotton and of wheat, winter barley, and spring barley following cowpeas at the Lawton field station, 1920–1930*

Crop	Treatment and previous crop	1920	1921	1922	1923	1924	1925
Wheat	Early fall plowed: Wheat	1,370	825	160		2,228	220
Oats	Fall plowed: Wheat	1,700	1,070	1,050	1,760	1,680	710
Wheat	None: Cotton	1,140	840		1,028	1,967	218
Oats	Disked: Cotton	2,000	1,160	1,430	1,340	2,200	740
Wheat	Disked: Cowpeas				1,150	2,465	540
Winter barley	do				500	3,320	0
Spring barley	do				410	1,500	90

Crop	Treatment and previous crop	1926	1927	1928	1929	1930	Average 1920–1930	Average 1923–1930
Wheat	Early fall plowed: Wheat	1,710	958	930	582	382	[1] 937	[1] 1,002
Oats	Fall plowed: Wheat	930	600	1,050	810	1,250	1,146	1,099
Wheat	None: Cotton	1,377	622	937	565	135	[1] 883	856
Oats	Disked: Cotton	1,080	580	1,110	890	1,420	1,323	1,245
Wheat	Disked: Cowpeas	1,015	770	1,190	770	415		1,117
Winter barley	do	2,320	1,410	800	530	200		1,143
Spring barley	do	1,020	120	660	590	400		599

[1] 10-year average. [2] 7-year average.

During the eight years that wheat, winter barley, and spring barley were grown on disked cowpea land there was but little difference between the yields of wheat and winter barley, but both exceeded the average yield of spring barley by 518 and 544 pounds to the acre, respectively.

RESULTS WITH COWPEAS

Cowpeas have been used quite extensively in the rotations and tillage methods, in order to test their value as a legume crop in soil improvement and because of the comparative ease of preparing a seed bed for the crop subsequent to cowpeas. The cowpeas have been grown in cultivated rows, being planted about May 15, and harvested as a hay crop when the first pods began to turn brown. The quantity of seed produced varies somewhat with climatic conditions, but depends more directly upon the variety. From 1916 to 1920, inclusive, the Early Brabham variety was grown on the rotation plots. This is a coarse-growing, late-maturing variety that produces a very small amount of seed. From 1921 to 1928, inclusive, the Early Buff was used. This variety is a semierect type, matures early, and produces a medium growth of vine and usually an abundant quantity of seed. In 1929 and 1930 a Chinese importation, white seeded with a pinkish-brown eye, was used. This selection resembles the Black Eye cowpea in growth, but appears to be more prolific in the production of seed and fully as good in the production of hay.

The yields of cowpeas obtained during the 14 years from 1917 to 1930, inclusive, are shown in Table 18. The average yield for the 12 years 1919–1930 on fall-plowed kafir land exceeded that on spring-plowed kafir land by 335 pounds to the acre. Fall plowing again showed an increase of 398 pounds to the acre for the 11 years 1920–1930. When cowpeas were grown on milo land the difference between spring plowing and fall plowing for the 11 years amounted to 164 pounds in favor of the latter. Spring-plowed wheat and kafir land showed a difference of only 41 pounds to the acre in favor of kafir land. There was but little difference between the average yields of cowpeas on spring-plowed and fall-plowed cotton land, but the average of both methods was only 44 pounds to the acre less than the average of both spring and fall plowing on kafir land. Taken as a whole, the average yield of cowpeas on spring-plowed land for 11 years is only 180 pounds to the acre less than the average on fall-plowed land. These differences are not so important when it is considered that the yields represent the total crop in the form of field-cured hay. However, cowpeas have demonstrated considerable dependability of production and have averaged nearly 1 ton of field-cured hay to the acre.

TABLE 18.—*Acre yields (in pounds) of cowpeas grown by different methods at the Lawton field station, 1917–1930*

Treatment and previous crop	Plots averaged [1]	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average		
																For varying periods	1919–1930	1920–1930
Spring plowed:																		
Wheat	2	.....	700	5,200	2,000	2,250	2,100	1,150	2,200	1,275	975	2,300	1,425	3,475	1,200	[2] 2,019	2,120	1,850
Kafir	5	.....	.....	4,700	3,160	2,010	2,300	1,400	1,850	1,000	1,167	2,467	1,467	2,017	1,067	.....	2,125	1,891
Milo [3]	2	.....	.....	4,525	2,575	1,975	2,550	1,450	1,725	1,050	1,075	2,550	1,000	2,775	975	.....	2,019	1,791
Cotton	3	.....	.....	.....	3,000	2,717	2,067	1,250	2,200	1,400	1,100	2,150	1,500	3,533	1,217	.....	.....	2,012
Average	.....	.....	700	4,808	2,684	2,238	2,254	1,313	1,994	1,181	1,079	2,367	1,348	3,175	1,115	[2] 2,020	2,130	1,886
Fall plowed:																		
Kafir	2	6,000	1,200	4,350	3,300	3,225	2,500	1,850	2,200	1,275	1,125	3,075	1,625	3,800	1,200	[4] 2,623	2,460	2,289
Milo [3]	1	.....	.....	2,700	1,750	2,800	2,400	1,650	2,200	1,200	1,050	2,800	1,400	2,800	1,450	.....	2,017	1,955
Cotton	4	.....	.....	.....	3,600	2,500	2,000	1,400	2,230	1,213	1,225	2,538	1,513	3,413	1,238	.....	.....	2,079
Wheat	3	.....	.....	3,100	2,900	2,367	2,150	.....	.....	.....	.....	.....	.....	.....	.....	[6] 2,629	.....	.....
Sorgo	1	.....	.....	.....	2,750	2,550	2,350	.....	.....	.....	.....	.....	.....	.....	.....	[7] 2,550	.....	.....
Sudan	1	.....	.....	.....	3,150	2,200	2,100	950	.....	.....	.....	.....	.....	.....	.....	[6] 2,100	.....	.....
Sweetclover	1	.....	.....	.....	3,100	2,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	[8] 2,650	.....	.....
Average	.....	6,000	1,200	3,383	2,936	2,549	2,250	1,463	2,210	1,220	1,133	2,804	1,513	3,338	1,296	[4] 2,379	2,175	2,066
Fall list: Kafir	1	.....	.....	.....	1,800	1,350	1,350	.....	.....	.....	.....	.....	.....	.....	.....	[7] 1,500	.....	.....

[1] Greatest number at any one time. Not all continuous for entire period.
[2] 13-year average.
[3] Milo replaced by feterita beginning 1925.
[4] 14-year average.
[5] Milo replaced by feterita beginning 1924.
[6] 4-year average.
[7] 3-year average.
[8] 2-year average.

RESULTS WITH ALFALFA

Alfalfa has been successfully grown on the station in fields not suitable for plot work, but in rotation experiments it has been confined to one 6-year rotation. This provides for seeding each year a plot that is to grow continuously for three years. From 1917 to 1921, inclusive, the alfalfa was grown on fall-plowed wheat stubble. From 1922 to 1930, inclusive, the alfalfa was seeded on disked cotton land. Seeding was always done as soon as practicable in the spring, when soil-moisture conditions were favorable for germination and the danger from killing frost was past. Fall seeding, however, is practiced almost exclusively by farmers. When there is sufficient moisture in the fall to insure germination, this method of seeding results in an early growth in the spring, essential in preventing the growth of noxious weeds and grasses.

From 1919 to 1930, inclusive, one of the three plots in this 6-year rotation was grown in 44-inch rows and cultivated to prevent weed growth. Under this arrangement it is not possible to compare the yields of hay obtained from row plots and broadcast plots of the same age. However, the annual and average yields of hay produced by the two methods of seeding may be compared for the 12 years 1919–1930. The hay crop was an entire failure on the rowed plot in 1921 and on the broadcast plots in 1925. The yields of hay on the rowed plot ranged from 0 to 4,750 pounds of hay to the acre. On the broadcast plots the yields ranged from 0 to 6,250 pounds to the acre. The 12-year average yields of hay were 1,619 pounds on the rowed plot and 1,959 pounds on the two broadcast plots.

The first-year acre yields of hay ranged from 750 to 1,750 pounds on the rowed plot four times out of five that it was seeded. The first year's growth averaged 890 pounds of hay to the acre on the rowed plot and 235 pounds to the acre on broadcast plots. In the latter case only two cuttings were secured in the same year that seeding was done. The second-year yields of hay on the rowed plot ranged from 1,450 to 4,750 pounds to the acre, with an average acre yield of 2,530 pounds. The second year's growth of hay on the broadcast plots ranged from 1,500 to 6,250 pounds to the acre, with an average of 2,244 pounds, which was 286 pounds less than that on the rowed plot. The third-year hay yields ranged from 1,000 to 1,650 pounds to the acre for rowed alfalfa and 800 to 5,850 pounds to the acre on broadcast plots. The average yields were 1,317 pounds to the acre on the rowed plot and 2,569 pounds on the broadcast plots. The average yield of hay from all plots, rowed and broadcast, from 1919 to 1930, inclusive, was 1,833 pounds to the acre. For the 14 years 1917–1930 the average was 1,604 pounds.

Alfalfa does not satisfactorily fit into a short rotation, and a correct measure of its production can not be obtained in such an arrangement. The uncertainty and expense of obtaining a good stand makes it inadvisable to plow under an established stand so long as its growth is satisfactory. Grasshoppers were a serious menace to alfalfa in 1924. The plants are susceptible to injury from several other insect pests that are responsible for reduced yields at some time during the season nearly every year. Noxious weeds and grasses generally shorten the life of the stand and frequently constitute a very appreciable percentage of the first cutting of hay in the spring.

RESULTS WITH SWEETCLOVER

White sweetclover (*Melilotus alba*) was grown in two 4-year rotations from 1917 to 1930, inclusive. The difficulty met in growing this crop and the changes in crops in these rotations make it desirable to consider separately the results obtained in each rotation. The two rotations are designated as No. 133 and No. 134.

In 1916, 1917, and 1918 rotation No. 133 was arranged so that sweetclover was seeded with winter wheat on disked sorgo land and plowed under as a green-manure crop for oats. This practice proved to be so unsatisfactory for the sweetclover as well as for the subsequent crops that it was discontinued. Beginning with 1919, the rotation was changed to provide for seeding sweetclover on disked cowpea land. Under this arrangement sweetclover has been harvested as a hay crop. The yields of hay during the 12 years 1919–1930 ranged from 0 to 3,850 pounds to the acre, the average being 1,340 pounds. The hay frequently contained a very appreciable quantity of grass and weeds. Yields from the second-year growth were obtained in three years only. Weeds, grass, and dry weather so reduced the stand that reseeding was necessary in all but three years.

Rotation No. 134 provided for seeding sweetclover with oats on disked sorgo stubble in 1916, 1917, and 1918. This proved no more satisfactory than the arrangement in rotation No. 133 and was changed at the close of 1918. From 1919 to 1921 sweetclover was seeded on disked wheat stubble. Beginning in 1922, the rotation was revised, and sweetclover was seeded on disked kafir land. The yields obtained during the 14-year period 1917–1930 in rotation No. 134 ranged from 0 to 4,300 pounds to the acre. The average yield for the 14 years was 1,245 pounds to the acre. The hay contained a high percentage of weeds and grass. Dry weather and weeds and grass choked out and killed the stand of sweetclover, making it necessary to reseed every year but three. The average yield of sweetclover for the nine years 1922–1930 was 1,089 pounds to the acre on disked cowpea land in rotation No. 133 and 803 pounds to the acre on disked kafir land in rotation No. 134.

RESULTS WITH PEANUTS

Peanuts were grown on spring-plowed cotton land in a 2-year rotation from 1920 to 1930, inclusive. Rabbits destroyed the growing crop four times, and germination failed once during the 11 years. The average yield of peanuts was 14 bushels to the acre, and the annual yields ranged from 0 to 59.3 bushels to the acre. With very few exceptions the peanuts were of poor quality and very poorly filled out. There was less variation in the annual yields of hay, and it usually was fair in quality. The average yield of peanut hay was 1,294 pounds to the acre. This crop is best adapted to the sandy soils in this section and is grown to a limited extent much more satisfactorily on them than on the heavy upland soils.

SUMMARY AND CONCLUSIONS

The soils in southwestern Oklahoma differ widely in structure and composition, and erosion is a significant problem on most farms.

Rainfall is usually torrential in character, and its distribution is erratic. The summers are long and hot and protracted periods of

drought are frequent. Winter temperatures are generally mild, and the 214-day frost-free period provides a long growing season for a wide range of crops.

Insects are responsible for many low yields and failures.

The investigations do not show any cropping methods that may be depended upon to insure a good crop every year, but well-adapted crops show satisfactory averages over a period of years.

Corn can not be grown successfully on the tight upland.

Kafir is the best adapted of the grain sorghums.

Milo can not be grown successfully, largely because of its susceptibility to chinch-bug damage. Feterita is more susceptible than kafir to such damage, but has a place as a catch crop for feed. The heaviest tonnage of feed is produced by sorgo. Cotton is well adapted to conditions in the section and is its leading cash crop. Winter wheat, winter barley, and spring oats are successfully grown. Cowpeas are the most dependable legumes on upland soils. Alfalfa is more successful and productive than sweetclover.

Wheat did not show a marked response to differences in the time or depth of plowing. Spring-planted crops generally yielded better on fall or winter plowing than they did on spring plowing.

Listing and plowing were of about equal value as preparations for wheat, but listing was inferior to plowing for row crops, because of poor stands and retarded growth in the early season.

Neither small-grain nor row crops responded to fallow, the yields often being as good or better on land cropped each year.

Subsoiling was ineffective in overcoming drought, and did not result in satisfactorily increased yields of any of the important crops.

There is little in the results to recommend the use of green manure. Barnyard manure must be applied with discretion. Either barnyard or green manure may overstimulate early growth that may later fire and result in a reduced yield of grain. Cotton, corn, and sorgo showed small average increases in yield from the application of manure, but the grain yields of kafir and wheat were reduced by such application.

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