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Kansas Agricultural Experiment Station

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AGRICULTURAL EXPERIMENT STATION

KANSAS STATE AGRICULTURAL COLLEGE
MANHATTAN, KANSAS

CROP PRODUCTION IN SOUTHWESTERN KANSAS

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SUMMARY

The Garden City Branch Experiment Station is located on the so-called "heavy land" in southwestern Kansas. Experiments in dry-land farming have been conducted at that station since 1909.

The average annual precipitation for the 18-year period, 1908 to 1925, inclusive, was 18.23 inches.

The sorghums were the most consistent producers of grain and feed of any crops grown.

Winter wheat produced a fair yield when grown under good methods of farming.

Corn, spring wheat, oats, flax, and barley are unadapted except for a few local areas and for special purposes.

A rational farming system for the Southwest includes the production of sorghums, winter wheat, and live stock.

Summer fallow will reduce the probability of complete failure and is recommended.

Early fall listing was the best method of preparing small-grain stubble to be seeded the same season.

Dwarf Yellow milo was the highest grain-producing sorghum.

The tillage tests showed conclusively the value of spring cultivation of the seed bed for sorghum.

The last week in May and the first week in June is the best time to plant sorghums.

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E. H. COLES[2] AND F. A. WAGNER

INTRODUCTION

No section of Kansas has developed more rapidly during the past ten years than the southwestern portion, from Finney county south and west. The acreage in cultivation has more than doubled, the increase in the past two years being especially marked. This development is the more remarkable in view of the fact that it has taken place during a period of agricultural unrest, unsatisfactory returns for many farm products, and general retrenchment, especially in the older, better established farming regions, These facts seem to make it particularly desirable to consider in some detail the agriculture of this region with special regard to those practices which it seems may insure sound development and progress in the future.

It does not seem necessary to discuss the reason for the changes that have come about other than to suggest that it is in part due to the extensive use of improved machinery, such as the tractor and combined harvester-thresher, to the introduction, development, and use of crop plants better adapted to the region, and perhaps to more favorable climatic conditions than can generally be expected. Climatic conditions are worthy of special mention, since if recent years have been unusually favorable it may be expected that future years will be somewhat less favorable and that more attention will need to be given to those factors of safety, such as the production of live stock and of crops particularly adapted to the region, which may assist in surviving unfavorable periods.

Whatever the explanation may be, the changes above mentioned are bringing to the forefront many questions pertaining to the agricultural development of the region. It is particularly important to know whether present agricultural practices are sound. What are the opportunities for improvement? Are the crops generally grown by farmers best adapted to the soil and to the climatic conditions which may be expected to prevail? What variety of these crops

1. The experiments reported herein were conducted by the Garden City branch of the Kansas Agricultural Experiment Station and the Office of Dry-land Agriculture, United States Department of Agriculture, coöperating.
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should be recommended? What are the best methods of cultivation, including preparation of the ground, time, rate and method of seeding, etc.? Finally, to what extent and in what way should farming practices in southwestern Kansas differ from those sections farther east with which farmers in the Southwest are more familiar?

The authors do not expect to answer all of these questions accurately and completely; but they do hope to present the various problems clearly and concisely, analyze the situation as far as may be possible, and give such conclusions as their experience and the accumulated data of the Garden City Experiment Station seem to justify. As far as possible their conclusions are based upon definite experimental evidence secured at this station. They have felt free, however, to draw upon the experience of successful farmers in the region so far as it may be expected to assist in solving the problems of the Southwest.

The Garden City Experiment Station is located five miles northeast of Garden City on the upland lying north of the Arkansas river. The results of experiments conducted there are believed to be applicable in a general way to the upland soils of southwestern Kansas, though the sandy soils south of the river present somewhat different problems. The station was established in 1907 as a branch of the Kansas Agricultural Experiment Station. Experiments from 1907 to 1914 were confined to unirrigated land, but later provision was made for irrigation, and in recent years rather extensive irrigation experiments have been conducted. The present bulletin is confined to a discussion of the production of crops without irrigation, since by far the larger portion of the crops of southwestern Kansas is grown in this way.

SOIL AND CLIMATE

The soil on the Garden City Branch Experiment Station is typical of the so-called "tight" land of southwestern Kansas. It is a sandy loam, easily tilled except when very dry or unusually wet, retains moisture‘ well, and is very productive in years of ample rainfall and under irrigation.

The prevailing climate is typical of a large section of southwestern Kansas. The average rainfall for the 18-year period from 1908 to 1925, inclusive, was 18.23 inches. Fortunately, a large proportion, namely, 13.75 inches or 76 per cent, occurred during the growing season, April 1 to October 1. The monthly precipitation for the period is given in Table I.

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TABLE I.—Precipitation at the Garden City Branch Station for the years 1908 to 1925, inclusive.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal, Apr.–Sept.	Annual.
1908	.08	.67	.18	.50	.78	3.45	1.52	1.61	.61	.99	2.72	.23	8.47	13.34
1909	.30	.35	2.15	.07	2.50	3.44	5.10	1.31	1.43	.68	3.77	.70	13.85	21.80
1910	.50	.25	T	1.04	1.52	3.23	2.00	2.99	.14	T	.15	T	10.92	11.82
1911	T	3.53	.89	.32	3.19	.61	1.84	1.68	.23	1.85	.95	1.66	7.87	16.75
1912	.28	3.04	.98	2.55	.56	4.07	1.76	3.49	1.34	.33	.29	.05	13.77	18.74
1913	.15	1.15	.50	1.21	2.30	3.12	4.97	.87	5.47	.23	1.19	2.42	17.94	23.58
1914	.27	.20	.03	1.74	3.63	1.44	.56	.64	.15	1.48	T	.41	8.16	10.55
1915	.45	2.54	.93	2.67	4.39	2.96	1.66	6.60	2.27	1.79	.12	.13	20.55	26.51
1916	1.09	T	.60	2.80	.40	4.21	.20	3.89	1.16	.67	T	.51	12.66	15.53
1917	.30	0	.60	2.74	3.27	1.19	2.96	2.99	1.13	.13	.30	.16	14.28	15.77
1918	.34	.64	2.21	.79	2.48	1.91	3.58	.64	2.00	3.23	.13	3.10	11.40	21.05
1919	.18	1.52	1.53	2.24	.86	.60	3.00	1.12	3.20	1.65	.72	0	11.02	16.62
1920	.20	.23	.21	1.24	2.47	3.27	3.49	3.12	2.55	2.83	.86	.43	16.14	20.90
1921	1.02	.32	T	2.63	.96	5.81	2.21	2.25	2.46	.20	0	.65	16.32	18.51
1922	.24	.19	1.35	3.55	3.31	.64	2.05	2.49	.07	0	.49	T	12.11	14.38
1923	T	T	.41	3.92	6.69	6.88	4.52	3.86	6.19	3.10	.33	.29	32.06	36.19
1924	T	.76	1.73	2.08	1.06	1.39	1.09	1.74	1.73	.59	T	.55	9.09	12.72
1925	T	.46	.80	2.54	2.06	1.16	1.30	1.81	2.00	.28	1.01	T	10.87	13.42
Average	.30	.88	.84	1.92	2.36	2.74	2.43	2.40	1.90	1.11	.72	.63	13.75	18.23

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The distribution of the rainfall throughout the season is also important, since a plentiful moisture supply as the crop approaches maturity is essential to high yields regardless of the total for the season. This fact is important in relation to dates of planting, as it is often possible to time the crop so that critical periods in its development will occur when rains are most likely to fall, or when injurious high temperatures or hot winds are least likely to cause damage. This matter has been given considerable study in the experimental work of the station and will be referred to later.

The frost-free period at Garden City is practically identical with that of southern Iowa, the lower latitude being compensated for by the higher altitude. The average date of the last killing frost in spring is April 30, and that of first killing frost in fall is October 12. Since the sorghums and corn are not planted until the latter part of May or the middle of June, the last frost in the spring seldom affects them. In the fall, however, the rapidly cooling weather and shorter days after the middle of August slow up the maturing of the later growing sorghums and they are sometimes caught by frost. Only the milos, feteritas, and earlier-ripening kafirs can be depended on to mature.

Western Kansas has become unfavorably known because of its high winds. During February, March, and April they are particularly disagreeable, because the soil is dry and easily picked up and carried along with them. Considerable damage by soil blowing has occurred in the past, but the more intelligent tillage methods practiced in recent years have largely prevented this difficulty. High continuous winds combined with high temperatures in June may do much damage in drying up the ripening wheat, but this is true over much of the winter wheat belt. For nine months of the year winds are not noticeably more disagreeable than elsewhere.

Evaporation is very high, the average from a free water surface for the growing season, April 1 to October 1, being 52.7 inches. This is considerably more than for most other sections of the Great Plains and is one of the reasons for the uncertainty of crop production in this area. It also emphasizes the need for growing adapted crops only and employing those methods of farming which will most effectively conserve the moisture. Evaporation varies inversely with the rainfall, being much greater in seasons of low precipitation.

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CROPS TO GROW IN SOUTHWESTERN KANSAS

Since the rainfall of southwestern Kansas is comparatively low and the evaporation high, only the more drought-resistant crops can be grown successfully. This does not necessarily mean that southwestern Kansas is a region of low agricultural production, but it does mean that care must be taken in choosing those crops and the varieties of those crops known to be adapted to the region.

Winter wheat occupies the largest acreage of any field crop. The land is level to rolling and can easily be tilled with power machinery. This fact alone is conducive to the production of wheat on a large scale. Fields comprising from 300 to 600 acres are not uncommon. On many wheat farms all of the work is done with power machinery. The quality of wheat produced is usually good.

Even though winter wheat is the most popular crop in this section, it is not a sure crop and hence should not be the only one grown. At the Garden City Experiment Station wheat has failed completely in three of the past twelve years, namely, in 1917, 1918, and 1923. Yields were so low in 1916, 1920, and 1925 that it did not show a profit. In the past twelve years, then, it may be said wheat has produced profitable yields one-half of the time. There is undoubtedly a place for winter wheat in this region but it should not be grown exclusively. Considerable effort has been expended in studying cultural methods for winter wheat, and these will be discussed later.

The surest dry-land crops for the section under discussion are the sorghums. These crops have produced some feed for live stock every year in the past twelve. In 1916, 1917, and 1918 the grain yields were low but nevertheless some grain was produced on summer-fallowed land. Good yields of stover were produced by kafir every year. The sorgos (sweet sorghums or "canes") also produced large yields of feed each year.

The row crops above mentioned require the attention of the farmer for a longer period during the year than does wheat, as it is necessary to cultivate them during the summer. Neither are they so well adapted to power machinery. However, progressive farmers are learning to adapt power machinery to sorghum production and large acreages are being handled in this way. In considering a rational farming system for southwestern Kansas the sorghums must play an important part. The best varieties to grow are discussed later.

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Sudan grass, which belongs to the sorghum family, is undoubtedly the most satisfactory hay and pasture crop for the region. It has produced an average of approximately two and one-half tons of hay to the acre for the past five years at the Garden City Branch Experiment Station. The hay is of excellent quality when cut at the bloom stage, but becomes somewhat woody if allowed to become too mature. It is eaten readily by all classes of live stock and is an excellent pasture crop for both cattle and hogs.

One of the common complaints is that it is "hard on the land." Where Sudan grassland at the branch station has been listed or plowed in the fall, as good crops have been produced the following year as on other land. Kafir, for example, on fall-listed Sudan-grass stubble has produced as good yields as when planted on fall-listed wheat stubble.

Except for a few local areas corn is not adapted to this region. On the sandy soils it has produced fair yields, but on the heavier types it has produced only about one-half as much grain as Dwarf Yellow milo. At the branch station it has been grown since 1909 and has failed to produce grain in eight of the seventeen years. The best yields were produced in 1915, the average of a number of plots being 34.3 bushels of grain to the acre. For the entire 17-year period the average yield was 8.7 bushels of grain to the acre. The average yield when grown on fallow is about 5 bushels higher, but since this is not a practical method for corn this fact has no practical significance. The yields of corn are generally so low even with the best possible cultural treatment that there seems to be little excuse for growing corn on any but the sandy soils south of the river, and there is good reason to believe that even there sorghums will prove more productive.

If corn is to be grown, only the early-maturing varieties such as Colby, Freed White Dent, Cassel White Dent, and a few of local origin should be planted. The growing season is too short to mature standard corn-belt varieties.

For the most part the spring small grains are not profitable crops to grow in southwestern Kansas. Spring wheat was grown at the branch station from 1909 to 1920. The average yield for the period was only 3.8 bushels to the acre. Summer fallow has produced about two bushels more than the above but the difference is not great enough to warrant growing this crop by any method of culture.

Oats produced somewhat higher yields than spring wheat, but when considered from a money value standpoint were no more

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profitable. An average yield of 17.1 bushels of grain to the acre was produced on summer-fallowed ground, but only 10.9 bushels by the best of several other methods that have been tried. High temperatures preceding harvest are especially damaging to oats,

Barley has produced a smaller number of bushels per acre than oats, but the number of pounds of grain of the two crops is about the same.

While the yields of oats and barley are not large there may be some seasons when these crops should be planted. In a year when wheat fails to survive the winter the farmer has the extra area to take care of the following spring. He may not have enough equipment to summer fallow all of it and he may not wish to put it all into sorghums. Oats or barley may be planted with little or no seed-bed preparation if the ground had been well prepared for wheat. These crops will produce some feed which is available at least six weeks earlier than is grain from the sorghums. The land cropped to either barley or oats may be prepared and seeded to winter wheat the following fall. The seeding of oats or barley is particularly advisable when the ground is filled with moisture to the depth of a foot or more as a result of winter snow or late fall rain. It is seldom profitable to take a chance on these crops when the soil and subsoil are dry.

Flax is sometimes mentioned as a crop for southwestern Kansas. Attempts to grow it at the branch station have invariably resulted in failure and it cannot be recommended.

Alfalfa has not proved to be a satisfactory crop for the dry uplands of southwestern Kansas but is one of the most profitable along the Arkansas river where it can be irrigated or where it benefits by subirrigation or seepage from higher land. Those who have such land or who can irrigate will do well to grow a considerable acreage of this legume.

SUMMER FALLOW IN SOUTHWESTERN KANSAS

Perhaps the most certain way to grow a crop in southwestern Kansas is to fallow the land one year to conserve moisture for the following years. The land is cultivated sufficiently during the fallow season to control weeds but not enough to subject, it to soil blowing. This method, which is known as fallow or summer fallow, is especially adapted to growing wheat, (fig. 1) but may also be used for sorghums as described elsewhere in this bulletin.

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The principal objection to fallow are the expense involved in cultivating the land a year without a crop, the loss of the use of the land for a year, and soil blowing. Wheat sometimes grows too rank and lodges on fallow, and occasionally it is injured more severely than other wheat by hot winds. However, in experiments at the Garden City Experiment Station, yields of wheat and sorghums average considerably higher on fallow than where other methods are used, and in spite of the objections mentioned above there seems to be good reason for using this method much more generally than has been done in the past.

FIG. 1.—A field of winter wheat grown on fallowed land.

A RATIONAL SYSTEM OF FARMING IN SOUTHWESTERN KANSAS

Agriculture in southwestern Kansas cannot be put on a substantial basis until a rational system of farming is adopted. This involves not only growing crops adapted to the climate and soil, but also their relation to one another and to agriculture as a whole.

It has been pointed out that winter wheat, grain sorghums, and sorgos and Sudan grass for feed and pasture are the most dependable crops for this area. Obviously, then, these crops should receive major consideration.

It is well known that neither sorghums nor winter wheat should be grown on the same field year after year. They should be rotated but, as almost all practical farmers know, this is difficult to do because winter wheat is especially poor when planted on sorghum ground. This difficulty may largely be solved by introducing a fallow after the sorghum crop and preceding the wheat. A plan that

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has been found acceptable by many practical farmers is to fallow one year, grow two crops of wheat, and then a crop of sorghum. The latter may be grain sorghum such as milo or kafir, or it may be part grain sorghum and the remainder sorgos or Sudan grass for silage, rough feed, hay, or pasture. The farmer having a beef or dairy herd should plant enough sorghum on fallow to insure grain and roughage for his live stock.

If it seems desirable to grow a few acres of barley or oats when conditions are particularly favorable for these crops, they may be substituted for part of the fallow. The important feature is to provide a simple system adapted to the general climatic and economic conditions, which will provide for adequate rotation of crops and which is somewhat flexible and, therefore, may be changed to suit seasonal conditions. The details may be modified to suit the needs of each individual farm.

It should also be recognized that any permanent system must provide for some live stock. This may consist of dairy cows, beef animals, hogs, or poultry. Some beef or dairy animals are almost essential to utilize the feed and roughage that is always produced on every well-managed farm and which otherwise is wasted.

There are good reasons to believe that hogs may be cheaply produced on Sudan grass and in some areas on alfalfa pasture. These may be marketed as stockers or if grain (milo or kafir) is plentiful and cheap, as fat hogs. Poultry is rapidly becoming popular and rightly so, considering the climate and the usual plentiful supply of sorghum grain which is generally recognized as among the best poultry feeds the world produces. The forward-looking, progressive farmer will do well to consider these possibilities and adapt such of them as he can to his needs.

METHODS OF GROWING WINTER WHEAT

Several methods of preparing the land for winter wheat have been compared at the Garden City Branch Experiment Station. Summer fallow, early plowing, late plowing, subsoiling, and listing have been studied especially. The annual yields from 1914 to 1925 with averages for all years are given in Table II.

It will be observed that all yields are low regardless of how the ground has been prepared. Also it will be seen that there have been several complete failures as in 1917, 1918, and 1923, and almost complete failures as in 1916, 1920, and 1921. The data show that while

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TABLE II.—Yields of winter wheat per acre under different cultural methods at the Garden City Branch Station, 1914 to 1925, inclusive.

TREATMENT.	1914.	1915.	1916.	1917.*	1918.*	1919.	1920.	1921.	1923.*	1924.	1925.	AV.
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Late fall plowed	7.3	10.0	0	0	0	17.3	*0	3.8	0	14.0	0	4.8
Early fall plowed	6.3	10.0	0	0	0	21.0	*0	8.8	0	21.0	0	6.1
Subsoiled	6.7	9.9	0	0	0	19.5	6.7	5.8	0	17.3	0	6.0
Early fall listed	8.9	12.7	2.1	0	0	22.2	2.9	7.4	3.5	21.1	2.3	7.6
Rye plowed under for green manure	26.8	10.8	11.3	0	0	22.2	*5.7	12.0	1.2	18.0	4.2	10.0
Summer fallow	13.1	21.9	9.7	0	.5	21.6	5.9	11.9	2.2	21.5	12.6	10.8

* The yield given is for spring wheat seeded after winter wheat failed to germinate or winter-killed.

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some methods give better yields than others no method can assure a crop when seasonal conditions are particularly unfavorable.

Summer fallow and rye plowed under for green manure have given the best yields. Since growing rye and plowing it under for green manure is expensive, this method is not recommended. The advantages of growing wheat on fallow have already been pointed out.

METHODS OF PREPARING SUMMER FALLOW FOR WHEAT

The object of summer fallow is to conserve the moisture received in one year in order that it may be available for the crops produced the following years. To best accomplish that end it is necessary to get as much moisture into the soil as possible and at the same time to prevent the escape of the moisture after it once enters the soil.

Because of the interest in summer fallow as a method of growing wheat, a considerable amount of experimental work has been done to determine the best methods of preparing and handling a summer fallow. Five methods have been tried. These are (1) plowed early in the fall, allowed to go through the winter rough, and replowed in June; (2) plowed early in the fall, allowed to go through the winter rough, but not replowed; (3) allowed to go through the winter in the stubble and plowed early in May; (4) allowed to go through the winter in the stubble and plowed about June 20; and (5) listed early in the fall and cultivated level in the spring. In all cases the land has been cultivated sufficiently during the summer to keep weeds under control and the soil in good condition. The experiment was begun in 1914 and has been continued to the present time. The average and annual yields are given in Table III.

The highest average yield for the 12-year period was 14 bushels of grain to the acre and was secured from the fallow that was plowed twice, that is, in the fall and again in June. Plowing in the fall but without replowing in June produced 12.6 bushels per acre or 1.4 bushels less. Since the difference is not large enough to pay for the additional work, two plowings for fallow cannot be recommended.

The third highest yield, 12.5 bushels per acre, was secured where the ground was listed early in the fall. In this method the ground was listed after wheat harvest and was carried through the winter in the listed furrows. When weeds started growth in the spring it was lister-cultivated with the implement set to throw dirt to the ridges. As soon as the second weed growth started it was again lister-cultivated throwing the ridges in, leaving the surface as level as possible. After this cultivation the fallow was handled the same as that which had been plowed.

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TABLE III.—Yields of winter wheat per acre under different methods of fallow at the Garden City Branch Station, 1914 to 1925.

METHOD OF HANDLING THE FALLOW.	1914.	1915.	1916.	1917.*	1918.*	1919.	1920.*	1921.	1923.*	1924.	1925.	Av.
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Early fall plowed, cultivated in spring, and replowed in June	13.4	22.3	6.3	0	0	27.5	7.3	21.7	1.3	29.5	24.8	14.0
Early fall plowed and cultivated as necessary the following season	12.5	24.1	6.3	0	0	24.0	6.0	13.5	2.2	27.5	23.0	12.6
Through winter in stubble and plowed at corn planting time	10.3	20.5	8.5	0	2.2	23.8	7.7	*12.3	2.8	23.3	18.3	11.8
Through winter in stubble and plowed late in spring	9.5	13.2	4.7	0	0	22.8	6.0	*9.0	4.3	20.8	2.0	8.4
Early fall listed, through winter in furrows, and cultivated level in spring	9.5	19.2	3.3	0	0	26.0	6.0	20.0	2.2	26.3	24.7	12.5

* The yield given is for spring wheat seeded after winter wheat failed.

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This method is the least expensive one in the test, and since it produced almost as good yields as the plowing, is probably the most practical.

Those plots on which weeds were allowed to grow in the stubble until early in May produced only 11.8 bushels, or nearly a bushel less than the method just described. The stubble and fall weed growth caught and held some snow, but the delay in spring plowing enabled weeds to grow and use a part of the moisture that had been stored. Had the spring weeds been killed by earlier cultivation of the land, more moisture could have been conserved. Those plots in which weeds were permitted to grow until about June 20 gave markedly lower yields, the average being only 8.4 bushels per acre, or 4.1 bushels less than the best method, and but slightly better than when wheat is grown every year.

These tests emphasize especially the need of plowing or listing the ground to be fallowed in the fall or very early in the spring so that weeds will have no opportunity to use the moisture stored in the soil.

CULTIVATION OF FALLOW

The cultivation of the fallow during the summer previous to seeding is a point of considerable importance. Too much cultivation is likely to be as injurious or even more so than insufficient cultivation. In order to get the maximum amount of water into the ground it is necessary that the surface soil be kept open. Much of the rainfall in the Southwest comes in the form of downpours or torrential rains, and unless the surface soil is in good condition a large amount of the moisture is lost through surface run-off. If the soil has been a pulverized until a dust mulch is formed it runs together and forms an almost impervious layer. On the other hand, if the soil has been allowed to become packed, it is not easily penetrated by water. A fairly rough, cloddy surface will permit a better penetration of water than either of the two above-mentioned conditions.

Weeds cause the loss of more soil moisture than anything else. As soon as a weed puts leaves above ground it starts using moisture and uses it the more rapidly the longer it grows. If the maximum amount of water is to be stored it is therefore necessary that weed growth be prevented. For this reason it is advisable to start cultivating the land as soon as they make their appearance.

The net conclusion is that a fallow should be cultivated whenever it is necessary to control weeds and keep the soil open and in condition to absorb rain. Cultivation in excess of this is likely to

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be harmful rather than beneficial. Furthermore, it is wise to cultivate the fallow with those implements such as a duck-foot or spring-tooth harrow (fig. 2) which will leave the surface rough and cloddy rather than fine and dusty.

SOIL BLOWING

A frequent objection to fallow is the tendency of the soil to blow the following spring. If care is exercised to keep the surface rough and cloddy, as mentioned above, little trouble will be experienced.

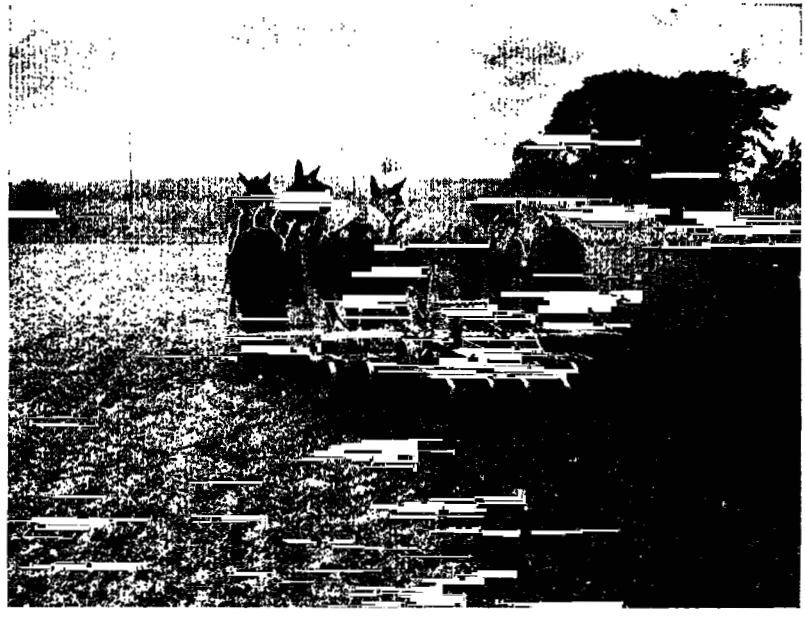

FIG. 2.—A spring-tooth harrow such as may be used in cultivating a fallow field.

In case blowing does occur, cultivating the field with a corn cultivator, with part of the shovels removed, at right angles to the direction of the wind, will reduce the damage. In extreme cases a lister may be used. Only a part of the land need be cultivated; a furrow every two or three rods often being effective. In either case some wheat, of course, is killed but the amount is generally less than if the soil blowing were allowed to take its course.

LISTING FOR WINTER WHEAT

Early fall listing (fig. 3) has given the best yields of any method when wheat is grown year after year on the same land. Early fall plowing has given nearly as good yields as listing, but since this

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method is more expensive than listing and is more favorable to soil blowing, listing may be recommended as the better method. However, it should be understood that the listing must be done early, that is, soon after harvest. Otherwise the ground may be too loose and it will be difficult or impossible to get wheat started in the fall.

Subsoiling has proved of no benefit and, moreover, is expensive. It cannot be recommended.

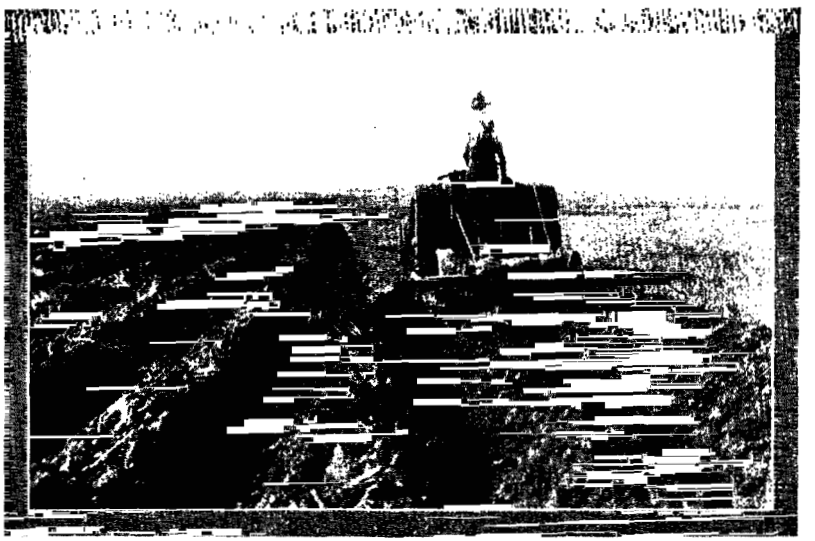

FIG. 3.—Early listing for winter wheat.

WHEAT AFTER CORN OR SORGHUMS

Very little experimental work relating to seeding wheat after sorghums or corn has been done. It is well known, however, that wheat does not usually produce a profitable yield after a sorghum crop. Recent experiments indicate that better results will be secured if the sorghum rows are spaced twice the usual distance, that is, about 7 feet apart. This method is gaining in favor among farmers and appears to be especially satisfactory on the sandy soils of the Southwest. Wheat may be sown between the standing stalks, leaving them stand to catch snow which in turn protects the wheat during the winter and adds to the available moisture supply. They also tend to prevent soil blowing in the spring, which is an important factor to be considered on the lighter soils.

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PREPARING SOD LAND FOR WHEAT

A considerable acreage of wheat is seeded each year on sod land broken out during the spring just previous to seeding. Sod land usually produces a very satisfactory yield if the seed bed is well prepared. No experimental work relating to time of breaking sod has been done; but it seems to be the consensus of opinion among practical farmers that fall or winter breaking is unsatisfactory. The usual practice is to break in the spring, care being taken to run the plow as shallow as possible and completely turn the sod. A good practice is to follow the sod breaker with a roller that presses the freshly turned sod down until a good contact is made between it and the bottom of the plow furrow. This practice helps keep the surface soil from drying out. After the sod has been broken it should be worked enough during the summer to prevent weed growth. Cultivation in excess of this is usually wasted effort.

TIME OF SEEDING WHEAT

The time of seeding wheat in this section varies with the different seasons. In years when moisture conditions are favorable wheat is seeded early, but in dry years most farmers find it advisable to defer planting until rains occur. It is seldom advisable to seed in dry ground hoping that sufficient rain to germinate the seed will come later. Wheat planted in late August or early September often-makes too much growth, using moisture that would be of greater benefit to the crop if used the following spring. If planted as late as November it often fails to come up to a good stand. The optimum time for seeding, if there is sufficient moisture for germination, is from September 20 to October 20. It should be seeded at the rate of two and one-half to three pecks to the acre.

THE SORGHUMS

There are two principal groups of the sorghums, the grain sorghums, such as kafir and milo, and the sorgos commonly called sweet sorghum or cane.

Of the two types those grown for grain occupy the larger area. This is partly due, no doubt, to the fact that there is always a cash market for grain, whereas surplus roughage is not easily converted into money.

The grain sorghums usually command about the same price, pound for pound, as corn, the price varying from year to year. Milo usually sells at a little higher price than kafir.

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VARIETIES OF GRAIN SORGHUMS

There are numerous varieties of both types of the sorghums and several varieties have been tested in the experimental plots since 1921. The yields secured from the grain sorghums are given in Table IV.

TABLE IV.—Average acre yields of grain sorghums grown at the Garden City Branch Station, 1921 to 1925.

VARIETY.	Av. yield.
	Bus.
Dwarf Yellow milo	24.3
Dwarf White milo	22.6
Feterita	19.9
Darso	19.6
Sunrise kafir	19.5
Dawn kafir	19.2
Spur feterita	18.6
Pink kafir	18.2
Dwarf hegari	17.3
Red kafir	15.3
Blackhull kafir (standard)	15.3
Early White milo	13.6
Freed sorghum	10.0

Dwarf Yellow milo was the highest-producing variety in the test and was followed closely by Dwarf White milo. Common feterita ranked third with an average yield of 4.4 bushels of grain to the acre less than Dwarf Yellow milo. Feterita is a quick-maturing crop and will produce grain in most years when planted as late as June 30.

While Darso ranks high as a grain producer the seed is dark brown in color and is bitter. It is generally believed that such seed does not make as good feed as do most other grain sorghums, and it is not recommended as a crop for this section.

The two leading kafirs, Sunrise and Dawn, yielded at practically the same rate. There was a slight variation in stover yield favoring the Sunrise. Sunrise has a semi-sweet stalk and is thought to produce somewhat better fodder. Pink kafir has produced 18.2 bushels of grain per acre, or 1.3 bushels less than Sunrise. Spur feterita has produced a slightly higher yield than Pink kafir, but has produced on the average 1.3 bushels less than the common feterita, indicating that where this crop is to be grown the common variety should be planted. (Fig. 4.)

Dwarf hegari is a crop that has enjoyed considerable popularity in this section, but its yield in the test puts it down to ninth place as a grain producer. It makes very Satisfactory yields when grown under favorable conditions, but has not been able to produce so high yields in severe seasons as have the other grain sorghums.

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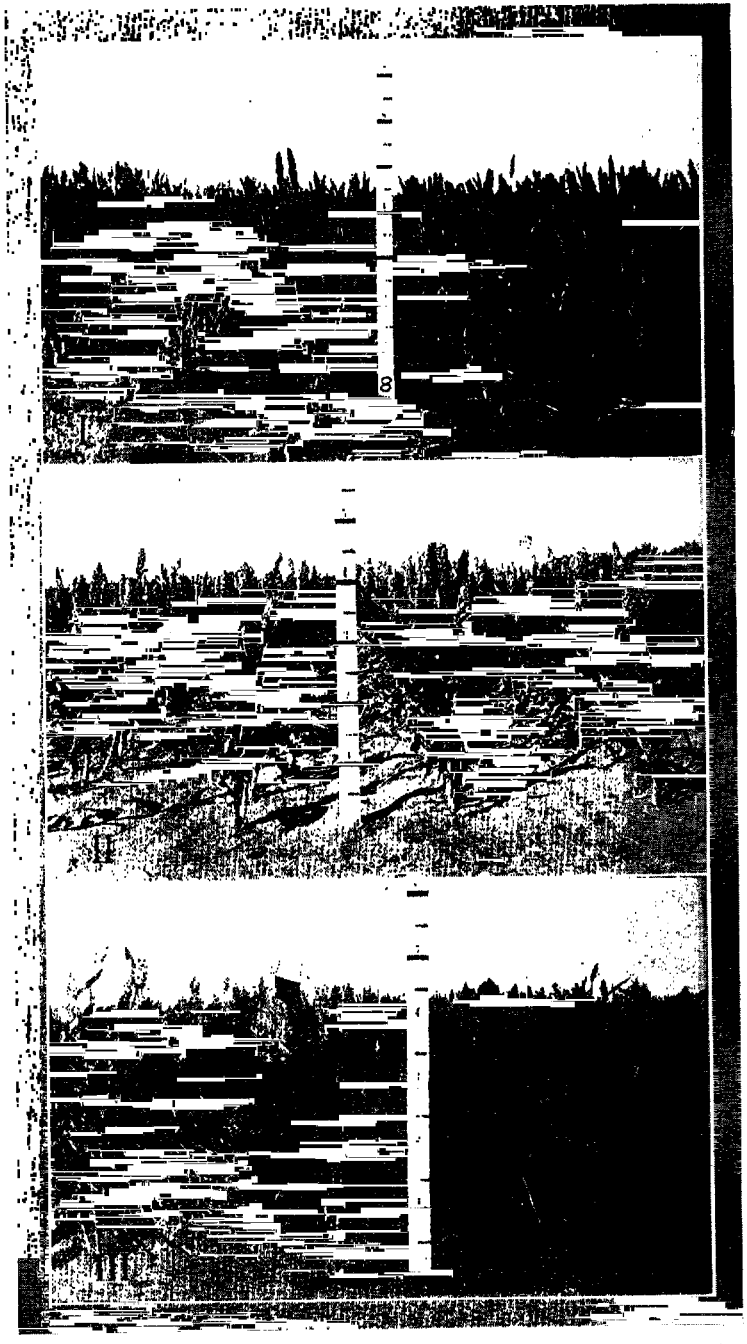

FIG. 4.—Grain sorghums grown on the Garden City Branch Station. (I) Pink kafir; (II) Dawn kafir; and (III) feterita.

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Both Red and Standard Blackhull kafir are late-maturing varieties which have not produced high average yields.

Freed sorgo ranks at the bottom of the list in yield of grain. It is an early-maturing crop that may be planted much later than most of the grain sorghums and still mature seed. For this reason it is often a satisfactory crop to plant late in the season.

Dwarf Yellow milo occupies the largest area of any of the sorghums in southwestern Kansas. A few fields of Dwarf White milo may be seen but they are rather scarce. Early White milo has not been a consistent grain producer.

Many farmers prefer kafir to milo on account of the erect heads, less tendency to lodge, and better quality of roughage. Unfortunately, as noted above, no variety of kafir is known which produces as much gain as the better varieties of milo.

The milos have a tendency to bear their heads on recurved or "gooseneck" stems. The crook necks are objectionable, especially where the grain is headed while standing. The tendency to recurve varies in different seasons. In seasons when moisture is received at the time the head is emerging from the boot a large per cent of goosenecks will appear, while in other seasons a large per cent of the heads will be borne on erect stems.

A variety known as straight-neck milo is grown to a considerable extent in southwestern Kansas and western Oklahoma. Unfortunately it has not been included in tests at the Garden City station. It is said to mature somewhat later than Dwarf Yellow milo and also it seems to lodge or go down rather easily after a storm and after frost.

VARIETIES OF SORGOS

A number of varieties of sorgos have been grown for the past five years in coöperative tests. These have been harvested for silage. The average yields for each variety are given in Table V.

TABLE V.—Silage yields of the different sorgo varieties grown at the Garden City Branch Station, 1921 to 1925.

VARIETY.	Average yield per acre.
	Tons.
Honey (local)	6.8
Sumac (standard)	6.6
Kansas Orange	6.4
Red Amber	5.8
African Millet	5.3

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It will be observed that Honey, Sumac, and Kansas Orange produced the highest yields. Red Amber and African Millet failed to produce as high yields as the other three. The quality of silage produced from the different varieties was about the same. All of them produce a good quality of bundle feed when handled for that purpose. Red Amber is a quick-maturing variety and one that may be planted as late as July 1 and still produce good feed.

Sudan grass has also been grown in these experiments. However,

FIG. 5.—Sudan grass drilled in rows 8 inches apart, 1920.

it was used for hay rather than for silage and has been the most satisfactory crop for that purpose. It is also very satisfactory as a pasture crop. (Fig. 5.)

METHODS OF GROWING SORGHUMS

Since sorghums are the most dependable crops of the Southwest, rather extensive experiments designed to show the most satisfactory method of growing them have been conducted. Listing and surface planting, fall and spring plowing and listing, relative yields on fallow, and cultivation in the spring have received most attention.

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Spacing the rows twice the usual distance apart has also been tried to a limited extent. (Fig. 6.) The yields of these different methods are given in Table VI.

LISTING VERSUS SURFACE PLANTING

The common method of planting sorghums in western Kansas is to plant with a lister on ground which has not previously been prepared. With this method the seed is placed at the bottom of a relatively deep furrow. The furrow is gradually filled as the crop is cultivated. Since surface planting involves some preparation

FIG. 6.—Dwarf Yellow milo, grown in rows 88 inches apart.

TABLE VI.—Methods of planting kafir at the Garden City Branch Station, 1914 to 1925.

METHOD OF PREPARING THE GROUND.	Average yields per acre, 1914 to 1925.
	Bushels
Listed in the fall, ridges worked down, surface planted	18.1
Plowed in the fall and surface planted	17.1
Plowed in the spring and surface planted	15.4
Double disked early in spring, planted with lister	15.0
Listed in the fall, cultivated in the spring, and planted with a lister, splitting the ridges	14.9
Listed in the fall, cultivated in the spring, and relisted in same furrows at planting time	14.2
Listed in early spring, cultivated and relisted in same furrows at planting time	13.2
Fall listed, no cultivation in the spring, ridges split at planting time	11.3
Listed at planting time without previous cultivation	8.8

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of the land previous to planting, it is more expensive and is seldom practiced. It will be noted that in experiments at the Garden City station surface planting has given an average yield of kafir of about 17 bushels per acre as compared with 15 bushels for the best lister method and only 8.8 bushels per acre for the common method of planting. The difference as compared with the usual method of planting is more than enough to justify the extra expense. It seems, however, that the better methods of listing give so nearly the same yields that they, rather than surface planting, should be recommended when the difference in cost is considered.

EARLY CULTIVATION IS ESSENTIAL

The experiments show that the most essential point in preparing the land and planting sorghums is to control the weeds and get the ground in such condition that germination will take place promptly and the plants grow rapidly afterwards. If the land is not cultivated until time to plant, as is so often the case, the spring crop of weeds uses all the moisture, and when the ground is listed it comes up rough and cloddy. In such cases it is practically impossible to get it in good condition. As a result germination is slow and uncertain and the plants have difficulty in getting established. This is the principal reason for the low yields when sorghum is planted without previous preparation of the land.

FALL VERSUS SPRING PLOWING OR LISTING

Several comparisons have been made between fall and early spring plowing or listing for kafir and milo. In general it has made little difference when or by what method the land was stirred, providing only that it be done before or as soon as weeds started growth in the spring. In other words, it appears that the growth of weeds is the most important point to consider. Any method that will control weeds and get the land in good shape is likely to give satisfactory results, while certainly any method which permits weeds to grow until planting time will not, in general, prove satisfactory.

It will be seen that all methods which include early spring listing or disking have given good yields as compared with the common method of listing without previous preparation. Listing in the fall or spring and splitting the ridges at planting time, sometimes called double listing, is an expensive method and in these tests has not given any increased yields.

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SPRING CULTIVATION

If for any reason land cannot be plowed or listed in the fall or early spring, some cultivation before weeds start is advisable. A disk-harrow may be used for this purpose. In experiments conducted for 12 years, double disking in the spring about the time the weeds started to grow has produced on the average 6.2 bushels more than land treated in a similar way but without the disking.

SORGHUMS ON FALLOW

Milo and kafir grown on summer fallow prepared as described for winter wheat have produced yields materially larger than for other methods. Thus milo has produced 29.7 bushels per acre on fallow as compared with about 18 or 19 bushels by other methods. Kafir has produced an average yield of about 23 bushels as compared with about 17 for the best other method, or about 10 bushels for the methods commonly followed in the Southwest.

In considering these increased yields obtained from fallowed land one must take into account the fact that the land has been used two years in producing one crop, but perhaps more important is the insurance that fallow affords against complete crop failure, especially to the farmer keeping live stock, since a constant supply of feed is necessary in order to realize a profit.

If grain alone is to be considered, Dwarf Yellow milo is the better crop to plant as it returns a greater number of bushels of grain following fallow than does kafir. If both roughage and grain are considered, kafir may be better than the milo.

TIME OF PLANTING SORGHUMS

All of the sorghum crops are very sensitive to a cold soil and the seed are likely to mold and die if planted under such conditions. In order to determine the optimum date for planting these crops, a date-of-planting test has been conducted. Five grain sorghums, two sorgos for forage, and Sudan grass have been planted on May 15, May 30, June 15, and June 30, each year for the four-year period, 1922 to 1925. The average yields for the grain sorghums are given in Table VII. The average yields for the sorgos and Sudan grass are given in Table VIII.

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TABLE VII.—Average yields per acre of grain sorghums planted at four different dates at the Garden City Branch Station, 1922 to 1925.

CROP.	Date of planting.			
	May 15.	May 30.	June 15.	June 30.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Dwarf Yellow milo	12.2	15.8	15.0	11.9
Dawn kafir	14.4	16.9	15.4	12.6
Standard feterita	10.1	14.6	16.9	16.2
Reed kafir	14.8	19.6	16.6	.....
Sunrise kafir	16.5	24.7	15.5	12.1
Average (Reed kafir omitted)	13.3	18.0	15.7	13.2

TABLE VIII.—Average yields per acre of sorgo fodder and Sudan grass hay planted at four different dates at the Garden City Branch Station, 1922 to 1925.

CROP.	Date of planting.			
	May 15.	May 30.	June 15.	June 30.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Standard sumac (sorgo)	6,106	7,019	7,506	.....
Red Amber (sorgo)	4,056	3,846	3,619	2,925
Sudan grass (hay)	5,184	5,482	5,269	2,955

May 15 appears to be too early to plant any of the sorghums. Good stands are seldom secured on early plantings. Early planted crops will head at a time during the summer when hot winds and dry weather are most likely to occur.

When planting was deferred until May 30, the soil was usually warm and a good stand was secured. Heading generally took place after the hottest weather of summer had passed. Later planting also permitted better preparation of the seed bed before planting. The ground can be cultivated before planting with less expense than it can after planting. It was necessary to give the earlier planting one or two more cultivations after the crop emerged than were necessary when the crop was planted May 30.

The earlier-maturing varieties produced satisfactory yields when planted as late as June 15. Milos, kafirs, and Standard Sumac were usually caught by frost before maturing when planted on June 30, and did not produce much grain. Feterita and Red Amber were usually ripe before a killing frost occurred. Sudan grass produced

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one good cutting of hay when planted June 30. For the most of the sorghums the optimum dates of planting seem to be the last week in May and the first week in June.

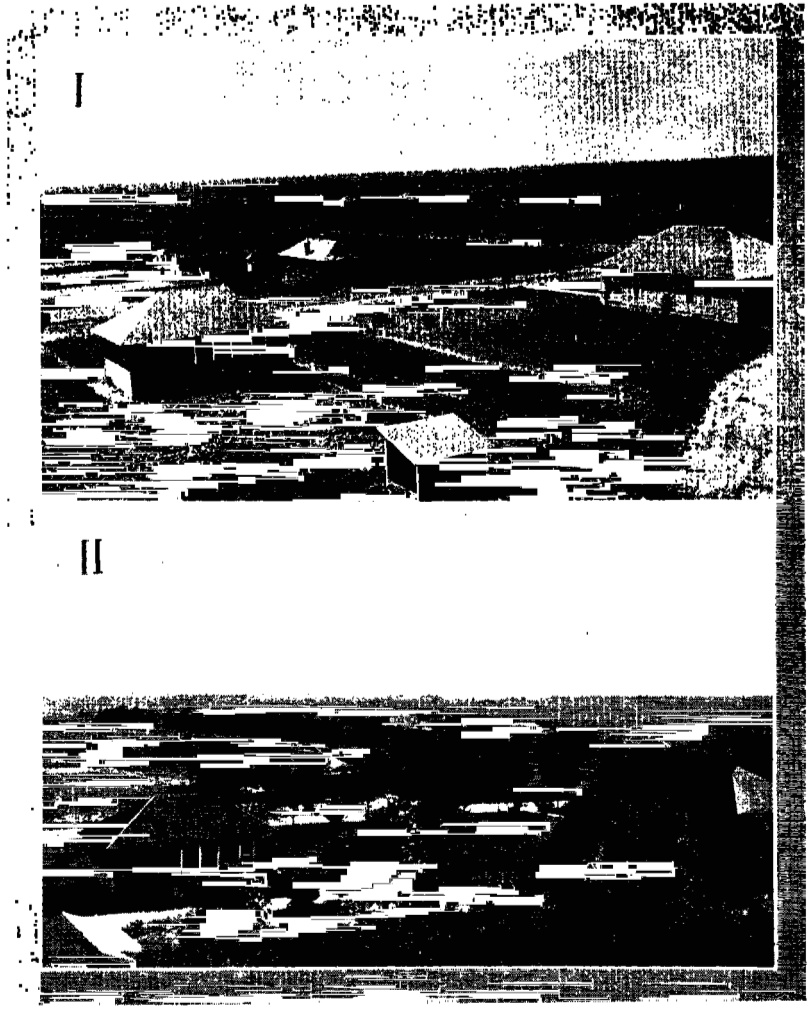

FIG. 7.—Bird's-eye view of the Garden City Branch Station. (I) 1918; (II) 1924.

TREES AND LAWNS

While the main efforts of the Garden City Branch Experiment Station have been directed to problems of crop production, some time has been spent in beautifying the farm grounds. Figure 7

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shows rather clearly what has been accomplished in the way of landscaping. Most of the trees shown growing around the dwellings are irrigated. The shade trees are white elm, Chinese elm, and ash. The Russian Olive has proved to be a very hardy ornamental tree both under irrigated and dry-land conditions. A good stand of Kentucky blue grass and white clover makes a very pretty lawn. The dry-land farmer does not have much water for irrigation purposes, but where there is a plentiful supply of water between 100 and 200 feet, as is the case in most parts of western Kansas, it appears that a lawn, garden, and a few shade and fruit trees could well be irrigated by windmill and would prove a most satisfying investment.

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