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GROWING CORN IN KANSAS.

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FOREWORD.

THIS bulletin was prepared by C. C. Cunningham of the Agronomy Department to supply the demand for information about the growing of corn in Kansas. The information contained herein is based in part on experimental data, and in part on the practices of the best farmers in different sections of the state. In order to make the bulletin as brief and clear as possible, all detailed figures accumulated in experimental work have been omitted.

Much credit is due S. C. Salmon for assistance and suggestions in the preparation of the bulletin. J. W. McColloch, of the Department of Entomology, prepared the portion of this bulletin treating of insects injurious to corn.

L. E. CALL, *Agronomist.*

GROWING CORN IN KANSAS.

By C. C. Cunningham.

INTRODUCTION.

KANSAS ranks sixth among the states of the Union in the production of corn, having produced annually in the ten years, 1905 to 1914, an average of 138,000,000 bushels, valued at $64,500,000. The average acre yield of corn for the state for this period was but 19.6 bushels.

Under average conditions, a yield of from twenty to twenty-five bushels an acre will be required to pay the actual cost of production when the producer is allowed a fair wage for his labor, proper compensation for the depreciation of his machinery, and a reasonable rate of interest for his investment. Because of the low yield, many farmers are growing corn at a loss or else are working for less than their time is worth.

The low acre yield is due mainly to the attempt that has been made to grow corn under conditions of climate and soil to which it is not adapted, to a lack of proper rotation of crops, and to the depletion of the fertility and humus content of the soil.

When corn is grown continuously upon the same land the yields tend to decrease. This is due to several causes. There are many insects which pass most of their lives on the corn crop, living on the corn during the growing season and hibernating in the corn stubble or on the near-by grass lands during the rest of the year. Since the available food supply is plentiful, the insects tend to increase in number year after year.

Moreover, many weeds are especially difficult to control in cornfields. If other crops, such as alfalfa, clover, and small grains, are occasionally grown, the weeds are more easily controlled, and many of the insects which feed on the corn but not on these crops die of starvation.

One of the most expensive plant foods present in Kansas soils is nitrogen. Corn uses this element in greater amounts than do most other crops. On the other hand, leguminous crops such as alfalfa, clover and cowpeas, have the peculiar

property of obtaining nitrogen from the air. Therefore, when these crops are grown in rotation with corn and utilized on the farm it is possible to maintain the nitrogen content of the soil indefinitely.

The cultivation of the soil which is necessary in growing corn destroys the himus and other organic matter. As a result, when corn is grown continuously, the soil becomes lighter in color, puddles more easily, absorbs less of the rainfall, and has a smaller water-holding capacity. The crops grown upon it are consequently less able to withstand drouth.

Grass crops restore a part of the humus that is destroyed in growing corn. It is easier and more economical to restore the organic matter by the addition of barnyard manure and by plowing under green manure crops when a rotation is practiced than when only one crop is grown.

Corn requires a better soil for its best growth than do other cereal crops. It is also more likely to be injured by unfavorable climatic conditions. It grows best on deep, fertile soils in warm, moist climates, with frequent showers and plenty of sunshine. It is especially liable to injury by drouth and hot winds when it is silking and tasseling and when the ears are forming. It is usually an unprofitable crop on poor soils. In those sections of the state where midsummer drouth, hot winds and poor soils are found, other crops, such as the grain sorghums (kafir, milo, feterita, etc.), can frequently be substituted to advantage.

AREAS IN KANSAS TO WHICH CORN IS ADAPTED.

The Agronomy Department, in its cooperative experimental work with farmers in all parts of the state, has made a study of the comparative value of corn and the grain sorghums. The map (plate 1) shows the state divided into districts based upon the relative value of corn and kafir or other grain sorghums as shown by these investigations.

In the northeastern part of the state (district 1 on the map) corn is nearly every year a more profitable grain crop than kafir or other sorghums. The soils of this area are well adapted to corn and the rainfall is sufficient to mature large crops of grain.

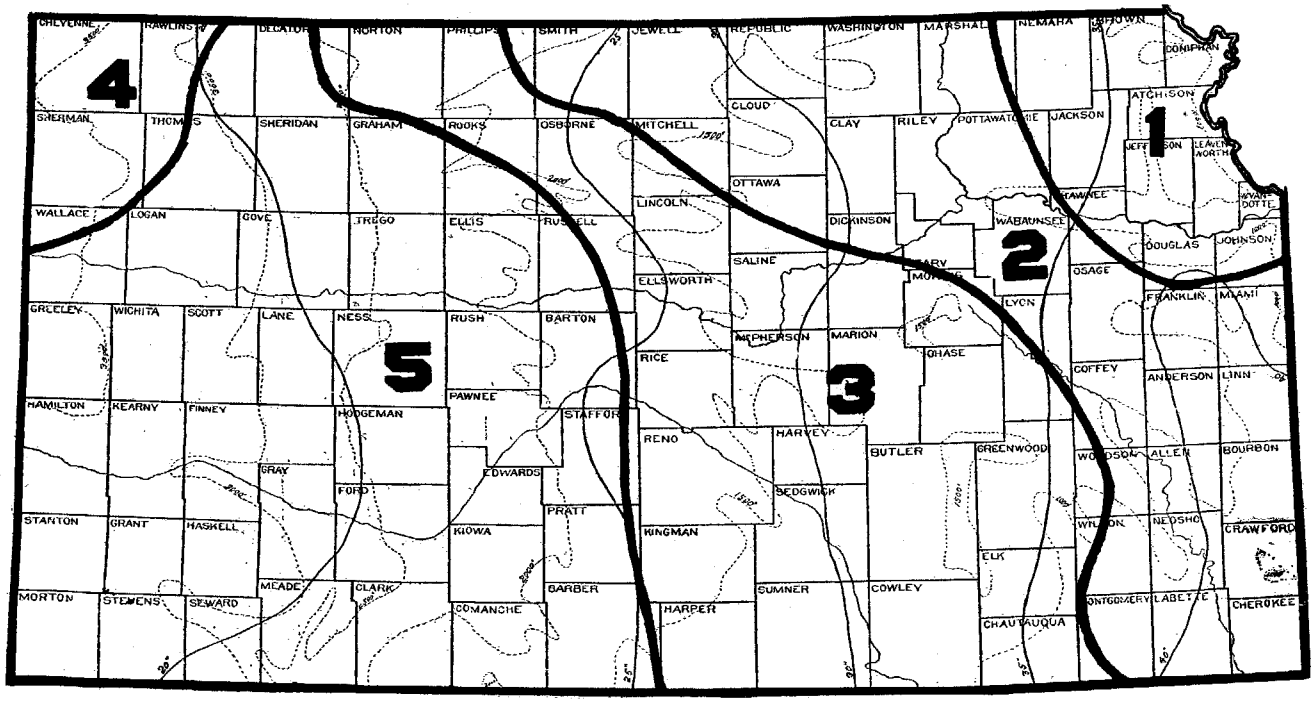

PLATE 1. A map of Kansas showing what areas are adapted to growing corn.

In district 2 corn is the better crop on the rich bottom land and on the deeper upland soils, but on poorer and more shallow uplands kafir usually gives better yields.

In district 3 kafir almost always outyields corn, and is more profitable except on the best land. Even on the latter, kafir is usually more profitable if it can be utilized as feed, as the total yield is usually greater.

In district 4 milo and feterita, which are also sorghum crops, but earlier than kafir, yield about the same as corn, on the average. The elevation here is great, which makes the seasons too short for kafir. Corn can be planted somewhat earlier than sorghums, and for that reason has a longer growing season.

In district 5 it is very seldom that corn will produce so large yields as the grain sorghums, and it is almost always a less profitable crop, even when the greater cost of harvesting the grain sorghums and the smaller value to the bushel is considered.

ROTATION FOR CORN.

A rotation of crops is good farm practice. By growing different crops the farmer is able to distribute his labor over a greater part of the year, and thus handle more ground with the same equipment and horsepower. There is less risk of a total failure, since if drouth or hail injures or destroys one crop the others may escape injury.

Where red clover can be successfully grown it is an excellent crop to use in a rotation with corn. Red clover is adapted for growing in sections 1 and 2 (see plate 2), with the exception of the prairie and more shallow soils in the western part of the areas and the shallow soils in the southern half of section 2. Clover also succeeds fairly well on the better types of soil in section 3. A rotation containing corn, wheat or oats, or both, and clover is perhaps the most practical one for the average farm in sections 1 and 2. The rotation can be varied to meet the needs of any particular farm. Corn may be grown one or two, or perhaps in a few cases, three years. It may then be followed by oats or wheat, and clover may be seeded in the small grain in the spring. Under normal conditions a good stand of clover will usually be obtained.

The first crop of clover is usually cut for hay and the second crop cut for hay or seed, or plowed under for green manure. The best results in maintaining soil fertility are obtained when the second crop is utilized for green manuring.

ALFALFA AS A ROTATIO CROP WITH CORN.

Alfalfa is an excellent crop to grow in rotation with corn from the standpoint of furnishing nitrogen and keeping the soil in good physical condition. There are, however, several disadvantages in using alfalfa in a definite rotation. In the first place, the rotation necessarily must be a long one. It is not advisable to use alfalfa in a rotation of less than twelve years, and often a rotation of sixteen or twenty-four years is more practical. The cost of seeding alfalfa is considerable, the failure to obtain a good stand is frequent, thus interfering with the rotation, and most farmers, after they have a good stand established, will not plow it up so long as the field is in a thrifty condition.

Alfalfa is well adapted to sections 3, 4 and 5, to the bottom lands of sections 6 and 7, and to parts of sections 1 and 2 (see plate 2). Alfalfa thrives well upon the best corn soils in these sections, and is, therefore, the logical crop to grow in rotation with corn. It is seldom advisable to break up alfalfa within five years after seeding, but it is doubtful if it should remain longer than from eight to twelve years. In central and western Kansas, and in dry seasons in eastern Kansas, considerable difficulty is experienced in growing corn on alfalfa sod. The corn makes a heavy growth, especially in the early part of the season, and produces an abundance of foliage, but does not produce grain. This heavy growth of foliage is probably caused by an abundance of available nitrogen left in the soil by the alfalfa. Because of the heavy development of foliage, a comparatively large amount of moisture is required to maintain and properly mature the crop. Unless the supply is abundant the corn will suffer before it reaches maturity. Vegetation of any kind that makes a quick, rapid growth is tender and succulent and very susceptible to heat and drouth. This is epecially the case with corn that grows rapidly during the early stages of growth.

Alfalfa also leaves the ground very dry. It reduces the moisture content of the soil to a point below that to which it

is ordinarily reduced by corn or other cereal crops. This fact, together with the conditions mentioned above, makes alfalfa sod undesirable for corn in the less humid portions of the state. Where corn can not be grown to advantage after alfalfa, kafir, sweet sorghum or similar drouth-resistant crops are the more profitable ones to grow in the first year or two. Corn can then follow these crops. While the effect of alfalfa may not be favorable to the crops immediately succeeding it, the ultimate effect of the nitrogen stored in the soil will prove beneficial.

Under normal conditions in eastern Kansas, and during years of heavy rainfall in central Kansas, comparatively large yields of corn are obtained on alfalfa sod. Under these conditions it is the most satisfactory crop to grow after alfalfa.

COWPEAS AS A CROP TO PRECEDE CORN.

In sections 2 and 3, in the southern part of sections 1 and 4, and in favorable seasons in section 5, cowpeas may be used to good advantage in a rotation as a crop to plow under to precede corn. A rotation in which cowpeas are used in this way is well adapted to those farms on which it is not practical to include hay or pasture grasses or other legumes in the cropping system, or on which such crops can not be grown frequently enough or manure applied often enough to maintain the nitrogen and organic matter supply of the soil. Cowpeas can also be used in this way on wheat or oat ground which has been seeded to clover but upon which the clover has failed to make a satisfactory stand. The cowpeas can be sown after oats or wheat is harvested, and in the average season will make a good growth of green material to plow under before frost. They should be planted as soon as possible after the small grain is harvested. As a rule it will not pay to plant cowpeas for green manure after the 20th of July except in the southern part of the state. An early variety, such as New Era, Groit or Whippoorwill, should be used.

THE KIND OF CORN TO GROW.

The precipitation, elevation and soil conditions vary so much in different sections of Kansas that the varieties of corn which grow best in one locality are frequently very poorly adapted to others. In eastern Kansas the annual rainfall averages 35 inches or more. In this area fairly large varieties usually

produce the largest yields. In western Kansas the annual rainfall is less than 20 inches, and the elevation is from 1500 to 2500 feet above that of eastern Kansas. If the large, late-maturing varieties of eastern Kansas are grown in this area they will invariably be injured by drouth, hot winds or early frosts. They may produce fodder, but they will not produce: grain. On the other hand, if the small, early-maturing varieties usually grown in western Kansas are grown in eastern Kansas they will ripen so early that they will not derive any advantage from the longer growing season and greater supply of moisture, and will consequently produce a low yield as compared with the adapted varieties.

Many soil areas in southeastern Kansas are deficient in plant food and humus. Earlier and smaller varieties must be grown than on fertile lands, as the supply of available plant food is not sufficient to mature the larger, later varieties. In any part of the state it is necessary to grow earlier and smaller varieties on the poorer soils than on the fertile lands.

Because of these radical variations in soil and climate, the state may be divided into nine corn-growing sections as shown in Plate 2. The division lines of the sections have been arbitrarily located. The characteristics upon which the divisions are based merge so gradually into one another that it would be impossible to locate exact dividing lines.

The soils of section 1 are derived largely from glacial drift, and usually are exceptionally well adapted to corn. As a rule they are deep, friable clay loams and silty clay loams, containing in the virgin state an abundant supply of organic matter. The varieties of corn most extensively grown in this section are Reid's Yellow Dent, Boone County White, Hiawatha Yellow Dent, and Iowa Silvermine. Reid's and Iowa Silvermine are medium early-maturing varieties and are best adapted to the uplands and the less fertile types of soil, while the other two varieties are larger and later-maturing and are usually grown on the best lands.

In section 2 the soils are residual in character and are derived largely from sandstones and shales. They are often deficient in organic matter and comparatively low in fertility. Practically all the soils of this section are silt loams, clay loams, and clays underlain by retentive subsoils of heavy clay. The northern portion of this section, as a whole, is better adapted

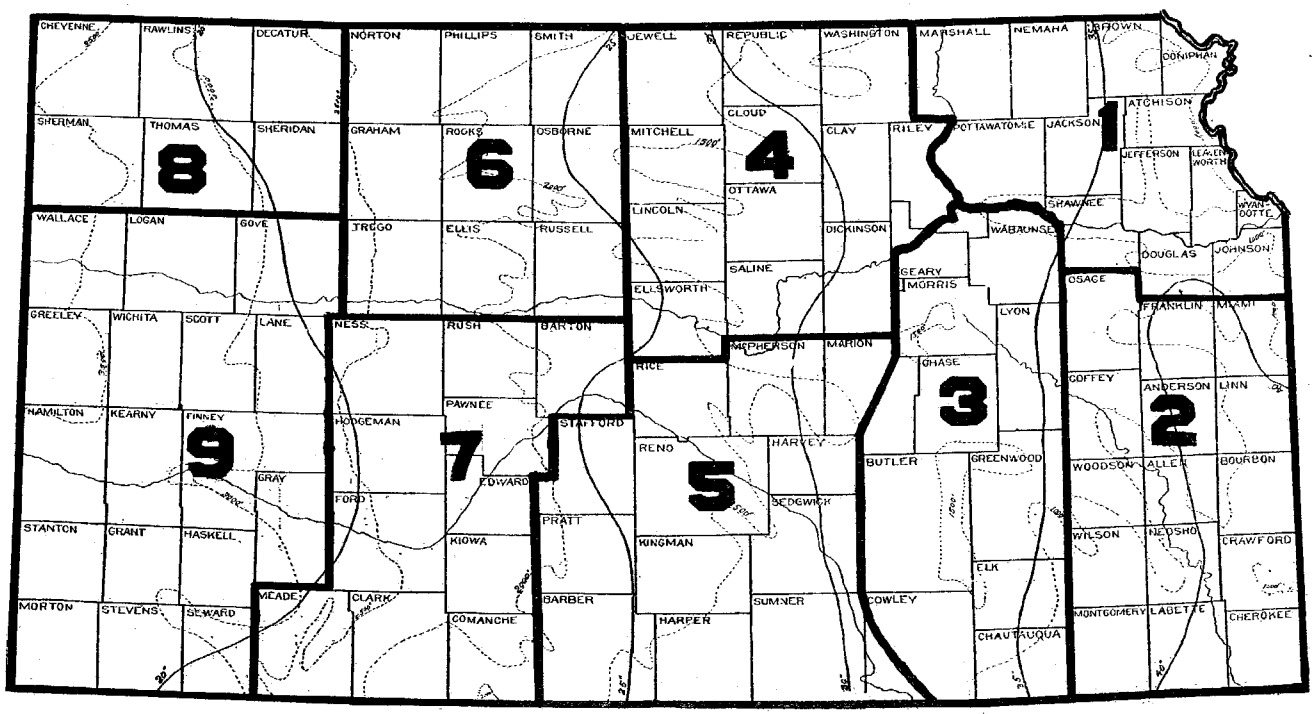

PLATE 2. **The nine corn-growing sections of Kansas. The division of the state into sections is based on differences in soil and climate.**

to corn than is the southern portion, because of the difference in the type and fertility of the soil.

Section 3 includes the "flint hills" and rough limestone country, which are largely pasture lands. Nearly all the upland in this section is poorly adapted to the production of corn because of the shallow nature of the soil. The creek and river bottoms make splendid corn lands, and on these soils corn is the principal crop. Some of the more level and deeper soils on the upland in the northern part of this section are well suited to the production of corn.

Pride of Saline, Iowa Silvermine and Kansas Sunflower are the varieties adapted to the uplands and thinner soils of sections 2 and 3, while Commercial White, Boone County White and Hildreth Yellow Dent are grown on the bottom lands and the more fertile soils. The last-mentioned variety is adapted only for strong soils. When grown on good land in favorable seasons, the Hildreth corn is a heavy yielder. For average seasons, however, the Commercial White is to be preferred to the Hildreth as well as to the Boone County White.

In the sections comprising the rest of the state, climatic conditions are the factors most likely togovern the productiveness of the corn crop. For this reason the divisions are based entirely on these factors. The soils of these sections are not so heavy as those of sections 1, 2 and 3; they are easier to till, cultivation is not delayed so much by wet weather, and weeds are more easily controlled. These sections are, however, more subject to drouth, and failures due to this cause are more frequent. Because of the difference in latitude, earlier-maturing strains must be grown in section 4 than in section 5. Section 5 is more subject to damage from hot winds than is section 4. Otherwise conditions for growing corn in the two areas are very similar.

As a rule, medium-sized varieties of corn, such as Pride of Saline, Iowa Silvermine, Kansas Sunflower and Reid's Yellow Dent, are best suited to sections 4 and 5. The Commercial White and the Boone County White do well on the better corn lands. The former variety matures too late to grow in the northern part of section 4. Reid's Yellow Dent and Boone County White are not so hardy or vigorous as the other varieties, and therefore are not so well adapted for growing under adverse conditions. These varieties often do not thrive well in

section 5 because of high temperatures likely to prevail in this part of the state.

With the exception of the northeastern part of section 6, the rest of the state is not well adapted for growing corn except on well-watered river- and creek-bottom soils. The sandier soils are better corn lands than the heavier types, especially those which are underlain with subsoils containing more or less clay.

Sections 6 and 7, and also sections 8 and 9, are very similar to each other as regards soil conditions and precipitation. The two northern sections, however, are much better adapted to the growing of corn than the two southern sections, in that they are not so subject to hot winds and high temperatures. The varieties of corn adapted to sections 8 and 9 must necessarily be hardy, small-growing and early-maturing, because of the short season and the light annual precipitation. Adapted strains of Iowa Silvermine, Pride of Saline and Kansas Sunflower are suitable for growing on the better soils in sections 6 and 7, while Freed's White Dent and other acclimated varieties are best for the uplands. For growing in sections 8 and 9, acclimated varieties, such as Freed's White Dent, Sherrod White Dent, Colorado Yellow Dent and adapted strains of Iowa Silvermine and Pride of Saline, are recommended.

In sections 6 to 9, inclusive, corn is often a total failure, and, as a result, seed of old, adapted varieties is frequently lost. In good seasons sufficient seed for at least two years' planting should be saved. Corn of good quality, properly stored, will make good seed after two years, and often three-year-old adapted corn will give better results than new seed that is not acclimated to western Kansas conditions.

Where a variety of corn is recommended for two or more sections, strains adapted to the respective sections should be grown. Iowa Silvermine corn grown on the fertile glacial soils of section 1 is not so well adapted to any other section as is an acclimated strain of that variety.

In every locality of the state there may be local strains or varieties of corn that have been developed in the respective localities as a result of careful selection of the seed for a period of many years. As a rule, these local varieties are exceptionally well adapted to the places where they were developed.

ACCLIMATED VARIETIES BEST.

Experiments conducted at the Agricultural College and cooperative tests conducted with farmers in various parts of the state show that home-grown seed of an acclimated variety and of good quality will outyield seed introduced from other localities. This is especially evident when corn is moved to a less congenial environment; that is, from a favorable to an unfavorable corn-growing locality. For instance, corn grown on the rich glacial soils of northeastern Kansas, or on similar soils in Iowa or any other eastern state, does not, as a rule, do well on the less fertile residual soils of southeastern Kansas. Varieties of corn moved west in the state a considerable distance do not usually produce so well as the acclimated varieties. Results obtained in cooperative tests demonstrate that where a variety of corn has been grown in a given locality for many years, and the seed properly selected each season, that variety is, as a rule, a superior one for growing in that locality.

This goes to prove that the general opinion among farmers that it is advisable to obtain new seed every few years is an erroneous one. The only time when it is desirable to change seed is when an inferior variety of corn has been grown or where the farmer has made no effort to select the seed properly year after year. In these cases it will pay to secure good seed from a near-by farmer who properly selects his seed, provided the soil conditions on the two farms are similar. If, for some reason, home-grown seed is not good in vitality or quality, better results can be obtained by securing first-class seed grown as near home and under conditions as nearly like those under which it will be planted as possible. Every farmer should select and save his own seed, as the corn which was grown on his farm is likely to be better suited for planting thereon than that grown elsewhere. Many farmers, however, would rather buy seed than go to the trouble of properly selecting and saving it. For this reason there will always be an opportunity in every locality for one or more farmers who are capable of producing good seed corn to build up a local trade, and thus dispose of a part of their crop at seed-corn prices. The community seed-corn grower or breeder

not only would be engaged in a profitable business for himself, but would furnish an opportunity for others in his locality to obtain seed suitable for growing on their farms.

PLATE 3. An adapted variety of corn grown in the same field and under the same conditions as the corn in plate 4. Note the comparatively more vigorous growth of the stalks and the larger size of the ears of the adapted variety.

PLATE 4. A nonadapted variety of corn grown in the same field and under the same conditions as that in plate 3. Note the absence of well-developed ears and the difference in the condition of the stalks as compared with the adapted corn.

METHODS OF GROWING CORN.

Two general methods of growing corn are employed in Kansas, namely, surface-planting and listing. The two methods are each adapted to certain conditions, and are superior one to the other only when the conditions to which they are respectively adapted exist. Modifications of both of these methods are practiced to some extent.

Listing.

Listing is a method of growing corn adapted to regions having a limited rainfall and comparatively light types of soil. This method is utilized to a larger extent than any other one in sections 3 and 4, and almost exclusively in parts of the state west of these sections.

In section 3 and the eastern portion of sections 4 and 5 listing may or may not give better results than surface-planting. The results depend on the type of soil and seasonal conditions. In the drier seasons listing is usually the superior method, while in the wetter seasons surface-planting may be best. Listing is often advisable for light soils, while surface-planting may give best results on heavy clay soils in the same area.

Under conditions to which listing is adapted, its advantages over surface-planting are many. The preparation of the ground previous to listing is not so expensive. In many parts of the state, indeed, no preparation whatever is given the ground before listing at planting time. Listed corn can also be cultivated and kept free from weeds much more easily than surface-planted corn. For this reason, a farmer can care for a larger acreage of listed than of surface-planted corn. Corn planted with a lister stands up better during the later stages of growth, and is very rarely blown down on account of the roots pulling out, while that which is surface-planted is subject to lodging.

Listed corn stands dry weather better, and, wherever moisture is usually the limiting factor in growth, listing is to be preferred. The greater resistance of listed corn to drouth is due to two reasons. The first is that the root systems of the corn plants begin their development deeper in the soil, and

therefore are not so subject to drouth as the shallower root systems of surface-planted corn. The other, and perhaps more important reason, is that, because of the less favorable growing conditions for the listed corn in the spring, the corn planted in this way does not produce so much or so tender and succulent foliage as that which is surface-planted. It is a well-known fact that vegetation which makes a quick succulent and abundant growth is not so hardy as that which develops more slowly and not so luxuriantly. Because of the greater leaf area produced by the surface-planted corn, more moisture is required for its maintenance than for that of a similar stand of listed corn. If moisture is the limiting factor during the later stages of growth, a given amount of it will maintain listed corn longer than surface-planted corn. Very often several days or a week or more added to the life of the crop will tide it over a drouth or will maintain it enough longer to permit of a considerable increase in the production of grain.

Corn planted with a lister does not germinate so readily as that which is surface-planted. There is also more danger of listed corn being covered by heavy, dashing rains, and in case of sloping fields it is likely to be washed out by water running down the furrows. On level fields, where drainage is not good, corn planted with a lister may be drowned out by water standing in the furrows.

DOUBLE-LISTING.

Double-listing consists in blank-listing either in the fall or spring, and in then splitting the ridges at planting time. This method often gives excellent results. It puts the land into ideal condition to absorb rains, and insures the stirring of all the ground, which is not the case where single-listing is practiced. Double-listing in the spring does not always give satisfactory results, especially if the weather is dry throughout the spring, because of the greater drying out of the surface soil due to its ridged and furrowed condition. Fall listing, especially where the rows run east and west, so as to catch and hold the snow, is usually a good practice. The opening up of the furrows exposes the subsoil to alternate freezing and thawing weather. This is desirable. At planting time the ridges may be split, or the corn may be planted in the same

furrow, depending upon the condition of the ground. Blank-listing early in the spring, and then planting in the same furrow with a lister, also form a good practice. More difficulty is usually experienced with weeds where this method of preparation is practiced than where the ground is double-listed.

BLANK-LISTING.

A practice that is rapidly coming into favor in certain sections in eastern Kansas is to blank-list and then plant the corn with a planter or drill a few hours or a day or two later, depending on the soil and seasonal conditions. Where the planting is delayed for some time after the ground has been listed, the bottom of the furrow has an opportunity to become

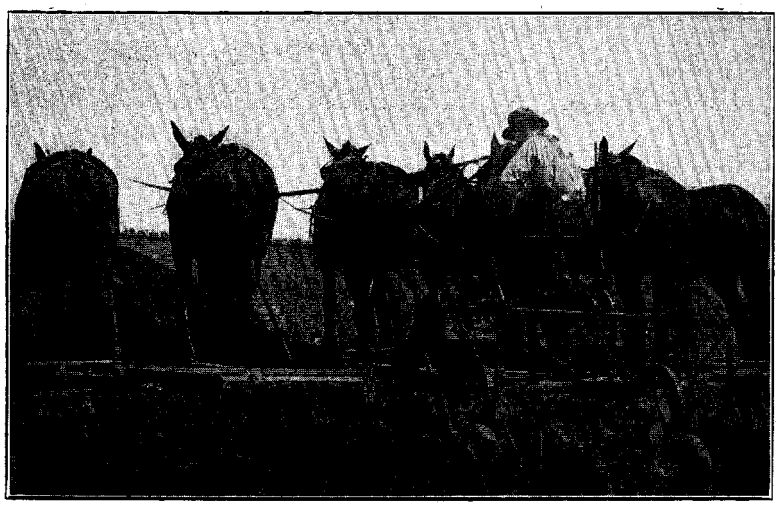

PLATE 5. Blank-listing for corn, which is planted a day or two later with a surface planter. (See plate 6.)

warm, and a better germination and a stronger early growth of the corn is obtained. Thus one of the disadvantages of listing is avoided, while all of the advantages are attained. This method is not practical in western Kansas, as the soil in the furrow is likely to become too dry to insure the germination of the corn, nor is it feasible in eastern Kansas on land where the subsoil is heavy and sticky and bakes readily.

Listing at right angles to the slope of the land or parallel to contour lines wherever practical, in order to prevent the loss of water by run-off and to avoid soil erosion, is a practice

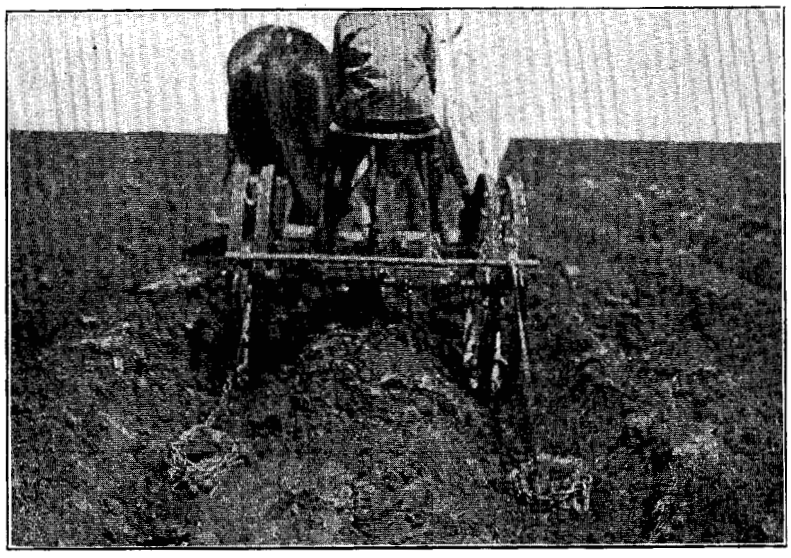

PLATE 6. Planting corn in lister furrows a day or two after listing.

that should be more generally followed, especially in the drier sections of the state. Where listing is done in this way, the lister furrows hold the water until it has an opportunity to soak into the subsoil, and the largest possible quantity of every rain is stored in the soil. The cultivation of the fields parallel to contour lines is a practice that will eventually become well established wherever moisture is the limiting factor in the growth of the corn.

THE DEPTH TO LIST.

The depth to list varies with the nature of the soil, the annual rainfall, and the time of planting. The lighter types of soils, especially sandy lands, may be listed much deeper than clay loams or heavy clays. In the eastern part of the state, where the rainfall is usually abundant in the spring, deep listing is not advisable, as it increases the danger of poor germination and the washing under of the corn. The usual depth is four to five inches; that is, the lister is adjusted so that the share runs about that distance below the surface of the ground, with the subsoiler set to loosen the soil in the bottom of the furrow an inch or so deeper. Toward the western part of the state, where the rainfall is lighter, the depth of listing may be increased. In west central Kansas and west-

ern Kansas the deep-listed corn is more resistant to drouth than that planted shallower, and for best results the listing should be done as deeply as the lister will work to advantage, which is six to eight inches below the surface of the soil.

The importance of deep listing can not be too strongly emphasized in western Kansas. Corn planted in this way will not make so great or so rapid a growth as that listed in shallow or at a medium depth, but it will stand drouth much better and is more certain of making a profitable crop. In planting corn in all parts of the state, early listing, or that done before the ground becomes warm, should not be so deep as that later in the season.

Surface-planting.

Surface-planting is adapted to heavy, wet soils and to localities in the state where the rainfall is excessive in the spring. In the parts of the state where the annual precipitation is more than 35 inches, nearly all the corn is and should be surface-planted. Corn planted in this way germinates better and makes a more rapid, vigorous growth during the early part of the season than listed corn, largely because the growing conditions are more favorable near the surface than in the bottoms of the lister furrows. Because of the greater growth of foliage, surface-planted corn develops a larger, more vigorous stalk and with a favorable season produces a larger yield than listed corn. Ground that is in condition for surface-planting does not wash so badly as that which is listed, and there is comparatively little danger of the young plants being destroyed by heavy, dashing rains. The plowing of the ground, which is necessary where corn is surface-planted, puts it into much better physical condition than can be obtained by listing ground, double-listing excepted.

FURROW OPENERS.

The furrow-opener method of planting corn is a modification of surface-planting and has several advantages of the latter method. The furrow openers consist of a set of disks that are attached to the shoe of the planter and open up a shallow furrow in which the corn is planted. A number of tests were conducted by the Agronomy Department of the Kansas State Agricultural college in which the furrow-opener method of planting was compared with ordinary surface-plant-

ing. The use of the furrow openers increased the average yield 4.1 bushels an acre in tests covering four years. Corn seeded in this way may be cultivated to a greater advantage than that which is surface-planted. The spike-tooth harrow may be used with less injury to the young corn, and the weeds in the row can be covered more readily by early cultivation. The root crowns start more deeply in the soil and the corn stands up better. In fact, many of the advantages of listed corn are obtained by the use of furrow openers.

In western Kansas, where it is necessary to cover corn deeply to prevent the drying out of the loose soil over and around the kernels, the furrow-opener method of planting is not always practicable, as the corn can not be covered deeply enough.

THE LOOSE-GROUND LISTER.

The loose-ground lister is practically a corn planter built strong enough to permit of the use of an extra large set of furrow openers which open a furrow almost as deep and large as those made with a lister. This method of planting is adapted to the lighter types of soils and to deep, friable loams that have been recently plowed or are in a fairly loose condition.

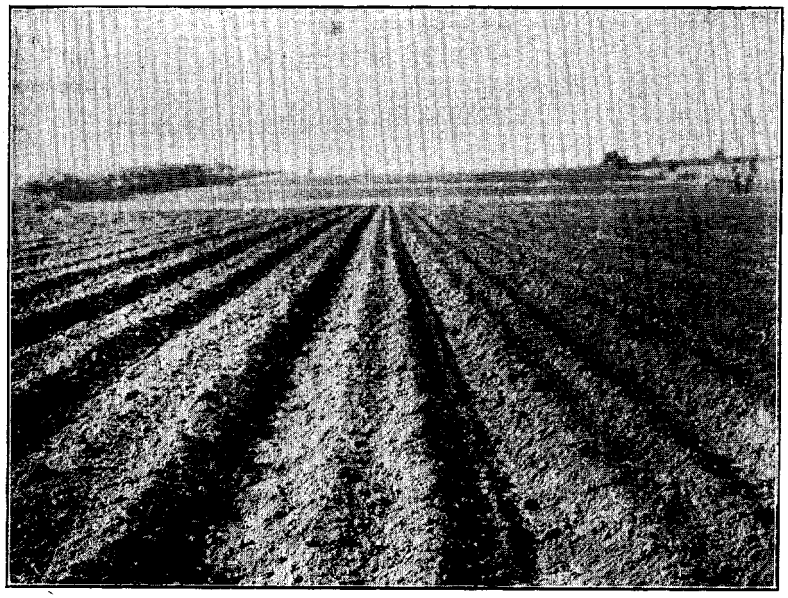

PLATE 7. Furrows made by the loose-ground lister.

The usual practice is to open up the furrows with the loose-ground lister and then follow with a corn planter or drill to plant the corn, although it is possible to plant at the same time that the furrows are opened.

PREPARING THE SEED BED.

The nature of the preparation of the seed bed for corn varies with the soil, the annual precipitation, the preceding crop, and the seasonal conditions, as well as with the method of planting employed. In most parts of the state thorough and early preparation of the land before planting is a profitable practice.

Preparing the Land for Listed Corn.

Since corn can be planted with a lister without any previous treatment, too little attention is given the preparation of the land where this method of planting is employed. The proper cultivation of the land before listing very rarely fails to produce paying results.

DISKING.

Spring disking is the most popular method of preparing ground for listed corn, and, on the whole, is very satisfactory. This treatment leaves the ground in excellent condition to retain moisture, often puts it into better condition to absorb moisture, cuts up and works into the ground cornstalks, trash and manure, thus hastening the decay of these materials, kills weeds that have already started and hastens the germination of those that have not sprouted.

The time to disk for corn in the spring depends upon a number of conditions. If the alternate freezing and thawing of the ground in the spring leaves the soil loose on top, disking is not necessary or advisable until a crop of weeds has started. If the ground comes out of the winter in a crusted condition, or is crusted by heavy early spring rains, disking as early as the condition of the ground will permit is advisable. A second disking is often advantageous if heavy rains pack the ground or a crop of weeds starts too far in advance of planting time. Disking puts the ground into better condition for listing and cultivation, and the advantage gained in this way is often sufficient to pay for the extra work of disking, even though no increase in yield is obtained.

PLOWING FOR LISTED CORN.

Plowing either in the fall or in the early spring, and then planting corn with a lister, form an excellent method of preparing a seed bed for corn, provided the ground becomes sufficiently settled to permit of a good job of listing. In this way the soil may be put into the best possible seed-bed condition if the right conditions exist.

The disadvantages of this method are several. It is not adapted to seasons with dry springs, especially on light soils, The cost of preparation and planting is larger than with the usual method of preparing ground for corn. If the soil is not firmly settled it will be impossible to do a good job of listing. Weed seeds turned under where the ground is plowed will be liable to germinate with corn in the bottom of the furrow, where they are hard to kill, making it difficult to keep the corn clean. Ground containing considerable trash can not be handled in this way.

Plowing the land for listed corn can usually be depended upon to give excellent results in normal seasons, especially on the heavier types of soil in section 3 and on the western edge of section 1 and in the eastern portion of section 4. (See plate 2.) This method is not recommended for other sections of the state.

Preparing Land for Surface-planted Corn.

Where the corn is to be surface-planted, fall or early winter plowing, as a rule, gives best results. Land fall-plowed is more thoroughly subjected to weathering agencies during the winter, which puts the soil into better physical condition, and tends to liberate in larger quantities the plant food locked up in the soil particles. Fall plowing also results in the destruction of many insects which are injurious to corn, and the destruction of these pests alone often makes it desirable to plow in the autumn. Heavy clay soils, when plowed early in the fall, often have to be plowed a second time in the spring for best results, because of the tendency of the soil to run together and become too compact. Sometimes the same condition is obtained in the case of late fall plowing if winter conditions are conducive to the settling of the soil. Unless the land is given proper cultivation before planting time, spring plowing in such cases will sometimes prove better than fall plowing.

Very often, because of lack of time or a crop being on the land, plowing has to be deferred until spring. Spring plowing should be done as soon as the condition of the ground will permit, since the longer the period between plowing and planting the greater the accumulation of moisture and plant food in the soil. Sometimes, during an open winter, conditions may be suitable for plowing in midwinter or late winter, and whenever possible advantage should be taken of such opportunities. Especially in the spring, care should be taken that the ground is in proper tilth when the plowing is done.

THE DEPTH OF PLOWING.

The depth to plow varies with the nature of the soil and the time when the work is done. Deep fall plowing, seven to eight inches, is advisable on nearly all good corn land. On thin soils, especially when the top soil has been largely eroded away, deep plowing may not be advisable, and in some cases may be injurious. Where the ground has not been previously plowed more than four or five inches, it is best to plow deeper gradually until the desired depth is reached, as turning up a considerable amount of unweathered soil may result in decreased yields for the first season.

PLANTING CORN.

CHECKING OR PLANTING IN DRILL ROWS.

Results of experiments show conclusively that, so far as yields are concerned, there is very little difference in planting in hills or in drill rows where equivalent stands to the acre are .obtained. The check-row method of planting permits of an easier control of the weeds, in that the corn may be cultivated both ways. This is often very important, as continued wet periods frequently give weeds an opportunity to obtain sufficient growth to make it difficult to cover or plow them out. The general practice where corn is surface-planted is to check-row rather than to plant in drill rows.

THE TIME TO PLANT.

The time to plant corn varies with the season and the locality. The growing season in southern Kansas is from two to three weeks earlier than that in northern Kansas. In the western part of the state the altitude is a factor influencing the time of planting, in that the season is shortened as a result

of the greater elevation. Under average conditions there is a period of about three weeks during which corn may be planted with equal chances of success, although sometimes, because of peculiar climatic conditions, very early or very late plantings are best. In section 1 and the northern portions of section 4, from May 1 to 20 is, on the average, the best time to plant corn, while in southern Kansas most of the corn is planted in the last three weeks in April.

When the ground becomes sufficiently warm to start the leaves on the deep-rooted trees, like the oak, the walnut and the Osage orange, it is time to plant corn.

The time required to mature the variety of corn grown is a factor to be considered. Early-maturing varieties may be planted comparatively late with good results, while late-maturing ones must necessarily obtain an early start in order to ripen properly. Since the top soil becomes warm earlier than the subsoil, the surface-planted corn may be seeded earlier than listed corn. A wet soil warms up more slowly than a comparatively dry one; therefore, corn can be planted in the drier soils earlier than in the wet ones. For this reason, early planting is safer in western than in eastern Kansas because of the naturally drier condition of the soil in the western part of the state. In southern Kansas, especially on the thinner uplands, planting as early as conditions will permit is usually advisable in order that the corn may be well along towards maturity before the hot, dry weather of midsummer.

RATE OF PLANTING.

It is a difficult matter to obtain always the proper stand of corn, for there are many factors beyond the control of the farmer that reduce the stand. The general tendency is to plant much too thick, with the hope that enough corn will survive to furnish a satisfactory stand. This practice is not desirable, as too often the stand secured is too thick for the best results. If the soil has been kept free from injurious insects by suitable methods of rotation, if a good seed bed is prepared for the crop, and if seed of strong vitality is planted at the right time and properly covered, the stand secured should be somewhere near that planted. Under these conditions the best results will be obtained by planting about as thick as, or a little thicker than, the stand desired.

The rate of planting should vary with the size of the variety, the fertility of the soil, and the average annual rainfall. A small-growing, early-maturing variety may be planted much thicker than a large-growing, late-maturing one. The planting should be thicker on rich, fertile soils than on soils thin and less fertile. On rich soils, however, the corn will often stool excessively, in which case rather thin planting is advisable. In eastern Kansas, where check-rowed surface-planting is practiced, two to four kernels are planted to the hill, with an average rate of three kernels a hill. Listed and drilled corn in the eastern part of the state is usually planted at the rate of one kernel every sixteen to twenty-one inches. A perfect stand at these rates, however, would ordinarily be much too thick. In easteran Kansas a stand that will average one stalk every twenty-one to twenty-four inches is amply thick to produce maximum yields under normal conditions. On unusually fertile soils thicker planting may be practiced to advantage. As the rainfall diminishes from eastern to western Kansas, the stand to the acre should decrease in the same ratio, or the size of the variety grown should decrease accordingly. As a rule, in central Kansas stands averaging twenty-four to thirty inches will give the best results, while in extreme western Kansas thirty to thirty-six inches is not too great a distance between stalks. Small-growing, early-maturing varieties of corn must necessarily be planted thicker than this to obtain maximum yields.

Results of numerous experiments show that the highest yields of stover can usually be obtained by thick planting. If corn is grown only for silage or for stover, planting from 50 to 100 per cent thicker than for grain is advisable.

THE DEPTH TO COVER CORN.

Corn should be planted sufficientlydeep to insure the kernels being placed in moist soil without danger of drying out. The depth is governed largely by the nature of the soil, by its mosture content when the corn is planted, and by the time of planting. As a rule, two to three inches is about right. On wet, heavy soils two inches, or possibly less, may be sufficient, while on light or sandy soils three, or perhaps four, inches is necessary for best results. Planting to this depth is often nec-

essary in western Kansas to prevent the soil around the corn from drying out. Corn need not be covered so deeply early in the season as when planted late, as the ground does not early in the season dry out so rapidly.

CULTIVATION.

Every farmer realizes the necessity of cultivating corn. Profitable yields can not be obtained without good cultivation. The principal object the average farmer has in mind in cultivating corn is to kill the weeds, which, in fact, is a most important object. Weeds rob the corn of moisture and plant food and decrease the yield in proportion to the amount that they use. There are, however, several other reasons for cultivating corn. A loose condition of the surface soil which is obtained by cultivation is necessary to conserve the moisture in the ground, and to absorb readily and to store the precipitation.

Cultivation also tends to develop plant food, an abundance of which is necessary if good yields are to be obtained. The natural agencies that bring about the formation of plant food are most active in warm soils well provided with moisture and the proper amount of air. Soils that are hard and compact do not permit of a sufficient circulation of "air to furnish the oxygen needed for the various activities taking place in the soil. A lack of air retards the development of plant food and interferes with the growth of the plant roots. Since cultivation conserves moisture and maintains the soil in a condition of good tilth, it indirectly increases the amount of plant food developed in that the right conditions for the formation of plant food are maintained.

The right kind of work in preparing the seed bed for corn will often reduce the amount of cultivation necessary after planting, which is important in that corn-cultivating time is usually the busiest season of the year.

After planting, the harrow may often be used to advantage on both listed and surface-planted corn. Surface-planted corn can be harrowed safely before it is up, but when the shoot is fairly out of the ground it is not best to harrow again until the corn is two or three inches high, and then preferably with a light harrow or weeder. Harrowing when the corn is small, especially with a heavy harrow, is likely to cover or destroy many plants.

Weeds that are just germinating or that have not yet obtained a good root-hold on the soil are very easily killed by light cultivations such as can be accomplished with the harrow or the weeder. A good harrowing at the proper time is often the cheapest and most efficient way of controlling weeds during the first stages of growth of the corn. The harrow or the weeder can also be used to advantage in breaking up a crust caused by a heavy, dashing rain.

The harrow is used but little on listed corn, mainly for the reason that the lister cultivator, an implement admirably adapted for use in cultivating corn planted in lister furrows, can ordinarily be used as soon as the corn needs attention. This implement, if properly adjusted, is very efficient in eradicating. weeds, and also does good work in stirring the ground. Ordinarily the lister cultivator is used twice—once with the disks set to throw the soil away from the corn, and once with the disks set to throw the soil to the corn—although an extra cultivation throwing the soil either out or in is sometimes advantageous. It is important that the cultivator be set to kill or cover all the weeds in the row, as those which escape during the early cultivations can not, as a rule, be destroyed or covered later. This applies equally to all early cultivation of corn, regardless of the method of planting or the kind of implement used.

The ordinary shovel cultivator is used almost universally in cultivating corn after it becomes too high to harrow, or, in the case of listed corn, after the ridges have been worked down with the lister cultivator. As a rule, listed corn is cultivated from two to three times with the shovel cultivator, while surface-planted corn receives from three to six cultivations. The number and character of the cultivations that should be given depends on the type of soil, on the distribution of the precipitation, and on whether the ground is foul with weeds or reasonably clean.

Many experiments have been conducted for the purpose of determining how often corn can be profitably cultivated. The results obtained show that, ordinarily, from four to six cultivations are as many as are practicable. Too frequent stirring of the ground, especially when it is dry, may do harm rather than good, in that the dusty condition of the soil which results

therefrom is effective in keeping rain-water from entering the soil readily, thus causing a greater run-off during heavy rains.

The ideal condition in which to maintain the soil is to have a mulch two to three inches in depth, composed of small lumps mixed with soil granules and reasonably free from dust. A mulch of this nature is effective in preventing the evaporation of moisture, and also readily absorbs and stores rains.

The proper depth to which to cultivate depends on the time when the work is done and on other conditions. On the average, two or three inches deep is best. While the plants are small and before the roots occupy the space between the rows, the ground may be stirred deeply with good results. Deep cultivation early is often necessary where the ground has been single-listed without any previous preparation, as it is important that the ridge between rows be thoroughly loosened. After the roots permeate all the soil, it should not be stirred to a depth of more than three inches. Practically all tests show that deep cultivation, which results in destroying a large number of roots, does more harm than good. Ordinarily it is safer to cultivate listed corn deeper than surface-planted corn, because the root system of the listed corn has started deeper in the soil. A large majority of the roots of corn, however, are found in the first six or eight inches of soil, regardless of the method or nature of the planting; therefore listed corn may be damaged almost as severely as surface-planted corn by too deep cultivation.

The six-shovel cultivator is a much better implement for cultivating corn than the four-shovel one, except where there is considerable trash on the ground or where the weeds are numerous and well rooted. The six-shovel cultivator stirs the top soil more thoroughly, leaves it in better condition, and does not destroy so many roots as the four-shovel cultivator, since the six small shovels do not have to penetrate so deeply as the four large ones to stir the soil completely.

The ordinary practice is to cultivate corn until it is too high to work with a two-horse cultivator. An extra cultivation or two with a one-horse cultivator may be given to advantage under certain conditions. This practice, however, may or may not be satisfactory. If rains have heavily crusted the soil shortly after the corn has been "laid by," or if a crop of weeds is starting, an extra cultivation with the one-horse cultivator will usually prove profitable. If, on the other hand,

the ground is in good tilth and reasonably free from weeds, nothing is gained by cultivating after the ordinary "laying by" time. These late cultivations should always be shallow to avoid damaging the corn roots.

SEASONAL CONDITIONS DOMINANT FACTORS.

Seasonal conditions vary so greatly from year to year that no one method of seed-bed preparation, planting or cultivation of corn will consistently give better yields than every other method. The farmer who by the exercise of good judgment uses methods of tillage that meet the seasonal conditions to greatest advantage is the one who, on the average, is the most successful.

The critical period in the growth of corn is during July and August, and drouth and hot winds during these months may destroy in a few days the accumulated benefits derived from thorough work in preparing the seed bed and caring for the corn during the early part of the season, which under favorable conditions would have resulted in considerable increases in yield. Very often, because of drouth during the latter stage of the growth of the corn, that which has the greatest capacity to yield because of the comparatively greater development of foliage is the first to dry up, while corn that has made a smaller growth because of poor cultural methods survives the drouth and produces the greatest yield of grain.

The farmer who consistently practices methods that conserve moisture and develop plant food, and who plants his crop opportunely, will, however, obtain the best average yields for a period of years.

HARVESTING CORN.

The general methods of harvesting corn practiced in the state are: cutting and shocking, and cutting for silage—practices in which the grain and fodder are both utilized—and husking the grain from the standing stalks. Until recently the latter method was by far most extensively employed. The value of stover is receiving greater recognition, however, and the practice of saving it for feeding purposes is becoming more general.

Corn should be cut for fodder when the bottom leaves be-

come dry, which, under ordinary conditions, is shortly after the ears become well glazed. At this time the corn possesses its maximum feeding value. If the corn is cut too soon it will be more subject to damage from weather and fungous growths and will yield less than if cut at the right time. If the cutting is delayed the stover deteriorates rapidly in quality.

The general practice is to cut the corn with a harvester and shock it in the field, where it remains, as a rule, until it is fed to the stock. As soon as the fodder becomes thoroughly cured, or at a convenient time in the late fall or early winter, many farmers stack it in large ricks in the barnyard, where it can be husked out and conveniently fed. This practice is a age one in that the damage caused by exposure to wet weather is to a great extent avoided.

PLATE 8. A well-stacked rick of corn stover, located where it can be conveniently fed to live stock.

The practice of husking corn from the field without utilizing the stalks except for pasturing cattle is a wasteful one. The plants after the ears have been removed if properly handled contain considerable feeding value, especially when used for silage. If because of drouth, poor yields of grain are secured, the per cent of feeding value in other parts than the ears is much greater than when the crop matures normally, while in case of total failure of the grain the entire value of the crop is in the stalks. The farmer who depends solely on

the grain for the results of his labor in growing corn is therefore obtaining only a part of the total value of his crop. This fact was demonstrated in an experiment conducted by the Animal Husbandry Department in 1912. In wintering calves it was shown that an acre of corn placed in the silo was as valuable for feed as the shelled corn from an acre of ground and the stover from three acres.

When corn is produced for the purpose of feeding cattle, the greatest returns can be obtained by utilizing it in the form of silage. The proper time to cut corn for silage is when the

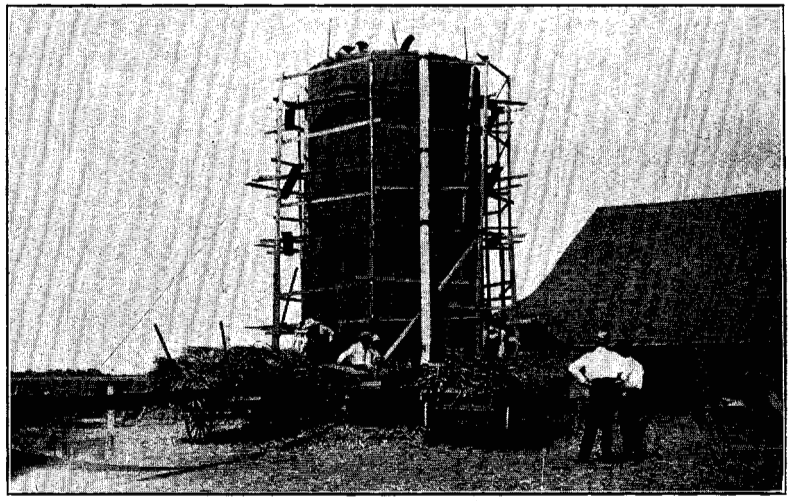

PLATE 9. Storing the 1913 crop of corn. Because of drouth this corn was of little value except as silage. The silo would not have been erected had a good crop of corn been grown.

ears become well glazed. Corn that fails to make grain because of drouth should be allowed to stand and mature as completely as possible without too great a loss of leaves as a result of the drying up of the stalks. In other words, the corn should be allowed to remain in the field as long as a considerable portion of the plants remains green, since the nearer the plants approach the normal ripening period the better the quality of the silage, even though no ears are produced. Corn that is nearly dry can be used for silage by the addition of the necessary amount of water to moisten it thoroughly as it is put into the silo.

The value of the silo for saving immature corn that has not matured properly because of dry weather was well shown in 1913, when corn of this character harvested in the usual manner and shocked in the field rotted in the shock and was practically worthless, while the same kind of corn placed in the silo made good feed.

"HOGGING DOWN" CORN.

"Hogging down" corn is a practice that is worthy of more extensive use in Kansas. This method of utilizing corn is entirely satisfactory if weather conditions permit. The hogs should not, however, be allowed to run in the fields when the ground is wet, as this will cause injury to the soil and may result in the grain being wasted. For the best results, the hogs should be limited to small areas rather than allowed to range through a large field. Where large areas are to be "hogged down" a temporary fence should be constructed confining the hogs to a few acres. The fence can be moved as soon as the first area is pastured down, and the process continued until the whole field has been utilized. The expense of harvesting is saved, and that which was produced from the field is returned to the soil with its maximum fertilizing value.

SHRINKAGE OF CORN DURING STORAGE.

Many farmers grow corn for the market, and it is often a question whether it is preferable to store the grain for higher prices or to dispose of it at the time when it is harvested. Whether corn should be stored, or sold as it is husked or soon after, depends on the corn market and the general supply and demand, the condition of the corn at harvest time, and the facilities available for caring for the grain. If the production of, and the demand for, corn are normal and the price is lower than economic conditions warrant, it is perhaps best to hold the corn. If, however, the price is within 25 per cent of what it will likely be at any time during the year under normal conditions it would be just as well to sell at harvest time, as very little would be gained in storing corn for an increase of 25 per cent or less. There is always more or less loss in storing corn, because of shrinkage, damage from weather, and injury by mice and other vermin. Experiments show that

reasonably dry corn when kept under the best of conditions will shrink in weight from 5 to 15 per cent when stored for a period of six or more months, the amount of shrinkage depending on the condition of the corn when cribbed and the seasonal conditions that follow. The natural shrinkage, in addition to loss due to rats, mice and insects, plus the extra work involved in storing the corn, is usually sufficient to offset a 15 to 25 per cent increase in the price of the grain.

SELECTING SEED CORN.

The vitality of the seed corn planted has much to do with the yield obtained. Seed of strong vitality that will germinate and insure a vigorous growth of the young plants, even though conditions are slightly unfavorable, is necessary if maximum yields are to be obtained. The general tendency is to disregard the value of the character of seed planted. Since one bushel of corn will plant from seven to twelve acres of land, from which, under ordinary conditions, there is obtained from three hundred to five hundred bushels of grain, it is evident that too much importance can not be attached to the selection and care of the seed corn. Every corn grower is warranted in spending considerable time or money in order to insure obtaining first-class seed.

There is only one really satisfactory method of selecting seed, and that is selection in the field after the corn becomes mature but before a freeze occurs. At this time the maturity and the conditions under which the ears selected were grown can be noted. If an earlier or later strain of corn is desired, ears of the desirable kind can readily be obtained. The conditions under which an ear is grown ordinarily determine its size. Some ears are larger than the average because of a thin stand or other advantages, while others are large because of the natural vigor of the plants upon which they were grown. The latter are the ones that should be selected for seed. If the seed corn is selected from the wagon or from the crib there is no way of ascertaining the conditions under which it was grown or from what kind of stalk it came.

The stalk is of as much importance in the breeding or improvement of corn as is the ear. Seed should be selected from strong, upright, leafy stalks of medium height that are largest at the ground and taper gradually to the tassel. The ears

should be attached at a convenient height for husking, should have a shank of medium length and diameter, and hang down sufficiently to prevent water from entering the tip. The stalks from which ears are selected should have been grown under average conditions: that is, where the stand is good and the corn has had no special advantages. Ears that range above the average in size are most desirable for seed purposes, but extremely large ones should be avoided. Experiments prove that moderately large ears—those that are a little above the average in size—are best for seed purposes, while excessively large ones often prove unsatisfactory.

The value of an ear of corn for seed—that is, the germinating power of the kernels—is governed largely by the conditions under which it matures. If an ear for some reason fails to mature properly, the seed is very likely to be deficient in vitality, and poor stands may be obtained because of lack of vigorous germinating power in the seed. The best indications of the proper maturity of the corn are a sound, firm condition of ear, and a bright, glossy grain. If the ear is not firm, and if the kernels are lacking in luster and are more or less discolored at the tip end, the chances are that the seed does not have the highest degree of vitality, although it may germinate under favorable conditions. Ears of this kind should be avoided, since they do not yield so well as those which are well matured.

From two to three times as many ears as will be needed for seed should be obtained in making the field selection, as many of them will likely be found unsuitable when a closer examination of the ear for kernel characters is made. The seed corn should be thoroughly dried, and stored under conditions where it will keep dry. Dry corn will not be injured by freezing. After the corn becomes dry it may be stored in any well-ventilated room or outbuilding where it will be free from rats, mice and other vermin. Corn that matures properly in the field can be stored without extra precautions in drying, but that which matures late and contains considerable moisture when the first frost occurs must be artificially dried to insure obtaining seed of maximum germinating power. One of the best places to dry corn is in the kitchen, the attic or some other well-ventilated room in which the temperature will be kept above the freezing point. As soon as the corn becomes thor-

oughly dry it may be transferred to a more convenient storing place.

If it is not possible to select the seed corn as has been suggested, the next best method is to make the selection at the time when the corn is gathered. Selecting ears at husking time can be easily accomplished with but little extra time and effort after a person becomes accustomed to it. A box should be attached to the side of the wagon for use in keeping the seed ears separate from the other corn.

In the winter a germination test should be made to determine whether or not the seed is sufficiently high in vitality. Secure a composite sample of corn, made up of several grains taken from different places in each of a hundred or more ears. Thoroughly mix these kernels and take a sample of at least one hundred grains for the germination test. If 90 per cent or more of the kernels germinate satisfactorily — that is, send out strong, vigorous sprouts — the seed is satisfactory. If more than 10 per cent of the seed fails to germinate satisfactorily,

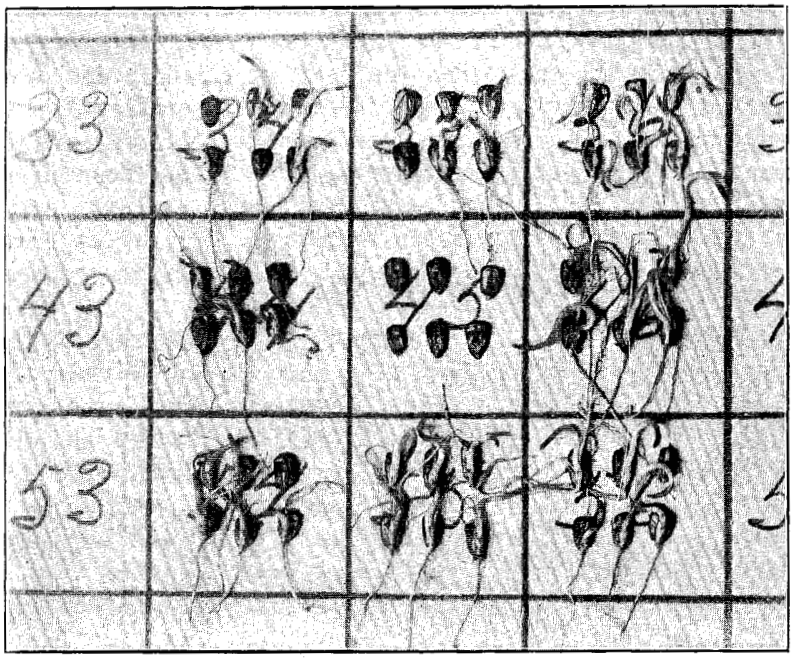

PLATE 10. Results obtained in a germination test of corn. The kernels in each square are from a different ear. Only three of the nine ears tested germinated satisfactorily.

other seed of known quality should be secured, or a test of each ear made and the ears of low vitality discarded. From ten to twelve ears of corn will plant an acre, and the amount of time required to test that number of ears is insignificant as compared with the results that will be secured by planting strong seed.

INSECTS INJURIOUS TO CORN.

The corn plant, like all other cereal and forage plants, is subject to attack from numerous enemies, such as insects, rodents and birds, While the number of insects infesting corn is very large, the number which cause any serious injury is exceptionally small. In Kansas there are probably not over twenty species of insects that may be regarded as seriously injurious to this crop. Only such insects as are of economic importance to the farmer will be discussed in this bulletin.

THE CHINCH BUG. The chinch bug is the most destructive and the best known of the insects injuring corn. Under favorable conditions it may cause an enormous damage to the crop, and in some cases entire fields may be destroyed. The greatest injury to corn occurs when the fields of small grains have ripened and the young bugs are forced to migrate to the cornfields, where they feed on the outside rows. As these plants are killed they advance farther into the field. Soon after reaching the corn the bugs become full grown, and then fly to all parts of the field to deposit their eggs. The injury from the second brood is not so noticeable, because of the general distribution of the bugs over the entire field.

The chinch bug can be prevented from migrating to the cornfieId by the maintenance of a dust barrier between the infested field and the cornfield. The dust barrier is made by plowing a deep lister furrow between the infested and the noninfested fields. The sides and bottoms of this furrow are reduced to a deep fine dust by dragging back and forth a heavy log wrapped with a log chain. After the bugs are trapped in this furrow they may be either burned with a gasoline torch or crushed with a drag. A dust barrier can not be made effective during wet weather, and under these conditions a road-oil or tar barrier is recommended. The most efficient means of controlling the chinch bug is to burn

over in the fall all grass and trash in waste places, roadsides, hedges and other such places, where the great majority of the bugs hibernate.

THE CORN-EAR WORM. With the exception of the chinch bug, the corn-ear worm is the most injurious insect attacking the corn plant. Every corn grower is familiar with the plump, green-striped caterpillar found in the curl of the ear. The insect is distributed over the entire state, and it is not unusual for from 90 to 100 per cent of the ears in the field to be infested. The injury by this pest consists in feeding on the tender curl of the plant and on the silk and forming kernels. The loss due to the actual eating of the grain is considerable, but it is greatly increased by the subsequent growth of molds and fungi on the ear as a result of the ear-worm infestation. Badly worm-eaten or moldy corn should not be fed to horses, as it sometimes produces a disease known as "blind staggers."

While there is no satisfactory way of absolutely controlling the corn-ear worm, the extent of injury may be greatly reduced by fall plowing and by planting as early as advisable in the spring. At Manhattan the optimum time to plant corn to reduce the amount of corn-ear worm injury to the minimum is about May 1. In southern Kansas the date is about April 20.

GRASSHOPPERS. Throughout western Kansas the grasshopper is a serious enemy of corn, and it is not unusual for large areas to be entirely devastated by this pest. The injury consists in the defoliation of the stalk, and often in the entire destruction of the plant. Grasshoppers can be effectively controlled in cornfields by means of the poisoned bran mash, This mash is made according to the following formula:

Bran	20	lbs.
Paris green	1	lb.
Syrup	2	qts.
Oranges or lemons	3	
Water	3½	gals.

In preparing the bran mash, thoroughly mix the bran and Paris green dry in a washtub. Squeeze the juice of the oranges or lemons into the water, and chop the remaining pulp and the peel to fine bits and add them to the water. Dissolve the syrup in the water, and wet the bran and poison with

the mixture, stirring at the same time so as to dampen the mash thoroughly.

The damp mash should be sown broadcast in the infested areas early in the morning, or about the time the grasshoppers are beginning to move about from their night's rest. It should be scattered in such a manner as to cover from four to five acres with the amount of bait made by using the quantities of ingredients given in the formula.

THE ARMY WORM. The army worm is a plump, greenish-black caterpiller, having three stripes along each side—the middle one dark and the others light—and a narrow broken stripe of white down the middle of the back. Army worms are most commonly found in grass land or in fields of small grain, especially rye. When they occur in large numbers they may do considerable injury to corn and other crops.

Where the army worms are migrating to the cornfield they may be destroyed by means of the poisoned bran mash discussed as a method of destroying the grasshopper.

This bran mash should be sown broadcast just ahead of the worms. The best time to scatter it is in the evening about the time when the worms are becoming active. The migrating worms may be destroyed by surrounding the field with a dust barrier and dragging a heavy log through this barrier.

THE CORN-ROOT LOUSE. The corn-root louse is a small bluish-green insect found on the roots of corn, and usually attended by small brownish ants. This insect is becoming a serious pest in Kansas and has caused a large amount of damage during the past few years. The injury consists of the weakening of the plant, causing it to make little or no growth and to turn yellow.

The corn-root lice are dependent on the small brown ants, which care for them at all seasons. During the winter the eggs are taken care of by the ants, and when the eggs hatch in the spring the ants carry the young lice to the roots of the corn. During the summer the ants continue their care over the lice.

The corn-root louse may be controlled by late fall plowing, which destroys the nests of the attendant ants, or by rotation. Where these insects are present corn should not be grown for more than two years in succession on the same land.

THE CORN-ROOT WORM. The corn-root worm is a small white larva, about one-half inch in length when full grown. It feeds upon the interior of the corn roots, boring holes throughout the length of the larger roots, and practically destroying their usefulness. Corn infested by this pest is very likely to have an unthrifty appearance and may go down badly. This insect can be successfuly controlled by rotation of crops.

THE MAIZE BILLBUG. The maize billbug has become a serious pest along the river valleys throughout south central Kansas. The adult beetles are black in color and about three-fifths of an inch in length. They deposit their eggs in the corn stalks, and the young worms burrow up and down the stalks, causing the plant to have a stunted appearance and often to sucker freely. Stalks injured by the billbug rarely produce ears. The chief means of control is rotation of crops. The billbug does not fly, and consequently is limited in its dispersal. The plowing out of the corn stubs in the fall will destroy a large number of the adults.

CUTWORMS. There are a number of species of cutworms which feed upon corn. Ordinarily they do little damage to the crop, but occasionally they become numerous enough to reduce greatly the stand. The cutworms are thick, soft-bodied, worms, which vary in color from whitish to dark brown or black. They are night feeders, and hide during the day in holes or under clods. In feeding they cut off the plant at the surface of the ground. The moths of the cutworms deposit their eggs mainly in grassland, and one of the chief means of the prevention of injury is not to plant corn on sod land. Where the worms are serious in a field they may be destroyed by means of the poisoned bran mash as described in the discussion of the grasshopper and the army worm.

WHITE GRUBS. The white grub is the larva of the common May beetle, or June bug. It has a thick, fleshy body, and when fully grown is about one and one-half inches in length. The body is curved in a horseshoe shape and is largest at the rear end. The bugs feed on the roots of the corn plant, thus depriving the plant of a part of its normal food supply, checking its growth and causing it to be easily blown over. This insect has not caused any serious damage in Kansas in the past, but it is on the increase, and serious injury may be looked for in the

future. The white grub is primarily a grassland insect, and one of the chief measures for preventing injury is to avoid planting corn on sod land. Other means of control are early fall plowing and rotation.

All the insect enemies of corn discussed in this bulletin can be largely controlled by proper handling of the soil and rotation of crops. Fall plowing of the land is very effective in destroying many of these pests, especially the corn-root louse. Where fall plowing is not practical, early spring treatment of the soil is often effective. The corn-root louse and the corn-root worm feed upon the corn plant alone, and therefore a rotation of crops readily controls these pests.

A rotation in which a crop or two of small grain are included is very effective in ridding the soil of insects, provided the ground is plowed soon after the small grain is harvested and is kept in clean condition for the rest of the season. When the ground is kept free from vegetation the insects are forced to migrate to other fields or starve.

OTHER CORN PESTS.

Ground squirrels and other rodents often damage corn by feeding upon the grain before or shortly after it germinates. Ground squirrels dig up the corn and the young plants. One or two squirrels will destroy all the corn on a considerable area. Crows often pull up the young plants in order to feed upon the kernel. Scattering corn, poisoned by soaking it in a solution containing strychnine, where these pests are working, is an effective way of getting rid of them. Care should be taken to prevent hogs or poultry from finding the poisoned grain.

SUMMARY.

Kansas produces annually more corn than any other cereal. The average annual yield of corn in Kansas for the ten-year period, 1904 to 1913, inclusive, is 19.6 bushels an acre.

The low acre yield of corn in Kansas is due primarily to growing this crop under conditions to which it is not adapted.

Corn thrives best on deep, fertile, friable loam soils, where the climate is warm and humid, with frequent showers and plenty of sunshine. It is easily injured by drouth and hot winds.

The average acre yield of corn in Kansas has steadily decreased, primarily because of depletion of the fertility and the humus of the soil and lack of crop rotation.

Rotations including corn, small grains and a legume are most practicable for most eastern Kansas farms.

Home-grown seed of an acclimated variety, suitable in size and maturity and of good quality, gives best results.

The popular opinion that it is necessary to change seed every few years is erroneous, provided the seed is properly selected.

Two general methods of planting corn are practiced in Kansas, namely, surface-planting and listing. The two methods are each adapted to certain conditions, and are superior one to the other only when the conditions to which they are respectively adapted exist.

The listing method of growing corn is adapted to regions having limited rainfall and light types of soil. Listed corn can be planted and cultivated more readily and cheaply than surface-planted corn, and is more drouth-resistant.

The surface-planting method of growing corn is adapted to regions having abundant precipitation and heavy types of soil. Surface-planted corn is not so susceptible to damage from heavy rains as is listed corn, makes a quicker and more abundant growth, and under favorable conditions develops a larger capacity for production.

Early and thorough preparation of the seed bed for corn usually results in profitable increases in yield.

The best time to plant in northern Kansas is from May 1 to May 20; in southern Kansas from April 10 to May1.

Much of the corn grown in Kansas is planted too thick. Under average conditions, a stand that will average one stalk every twenty-one to twenty-four inches in eastern Kansas, and every thirty to thirty-six inches in western Kansas, is sufficient to produce maximum yields. Early-maturing, small-growing, varieties should be planted thicker than large-growing, late-maturing varieties.

Experiments show that from four to six cultivations are as many as can usually be applied to corn with profit. The opportuneness of the cultivations is more important than the number.

Deep late cultivations that result in the destruction of many corn roots may do more harm than good.

Reasonably dry corn, when kept under the best of conditions, will shrink in weight from 5 to 15 per cent when stored for a period of six months or more, depending on the condition of the corn when cribbed, and the seasonal conditions that follow.

The vitality, or germinating power, of the seed planted has much to do with the yield obtained. A high degree of vitality in seed corn is best indicated by firm ears and bright, glossy kernels.

Seed corn should be selected in the field after the corn is mature and before the first hard freeze occurs, and should be thoroughly dried before it is subjected to freezing temperature.

A germination test should always be made to determine the vitality of the seed planted.