CORN IN MISSOURI

II. Field Methods That Increase the Corn Crop
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Agricultural Experiment Station

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II. Field Methods that Increase the Corn Crop

C. A. Helm*

Corn is Missouri's greatest crop. Its value usually exceeds that of the combined yields of both wheat and oats. On Missouri farms in 1919, for example, the acreage of corn was equal to all the fields of wheat and oats, while the value of the corn produced was one-and-a-half times the combined value of these leading small grain crops.

Yet the average yield of corn in all sections of the State is so low that in many cases the crop must have been produced at a loss. No other conclusion is possible from the reports of the Federal Bureau of Crop Estimates whose figures are shown in Table 1.

**Table 1.—Average Yields and Farm Values of Corn, Oats, and Wheat by Sections, for the Seasons 1908 to 1919.**

<table>
<thead>
<tr>
<th>Crops</th>
<th>Northwest</th>
<th>Northeast</th>
<th>Central</th>
<th>Southwest</th>
<th>Southeast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Bu.</td>
<td>Value $</td>
<td>Yield Bu.</td>
<td>Value $</td>
<td>Yield Bu.</td>
</tr>
<tr>
<td>Corn</td>
<td>27.8</td>
<td>23.00</td>
<td>27.8</td>
<td>21.85</td>
<td>24.6</td>
</tr>
<tr>
<td>Oats</td>
<td>28.1</td>
<td>13.80</td>
<td>27.5</td>
<td>12.90</td>
<td>25.6</td>
</tr>
<tr>
<td>Wheat</td>
<td>16.9</td>
<td>21.70</td>
<td>15.2</td>
<td>19.85</td>
<td>13.4</td>
</tr>
</tbody>
</table>

To discover and adapt to general application, therefore, principles that will increase the average yield of corn throughout the state is the greatest opportunity of the worker in field crops to add materially to the wealth of Missouri. To report the work already done toward this purpose by the Missouri Agricultural Experiment Station two bulletins have been prepared for publication as Parts I and II under the common title of Corn in Missouri. In Part I, issued as Missouri Experiment Station Bulletin 181, are considered corn varieties, their regional adaptability and their improvement by breeding, selection and care.

It is the purpose of the present bulletin to discuss the remaining factors by which the grower may increase the yields of corn, and to tell the results of experiments in these processes and conditions.

The possibilities of increasing Missouri's yield of corn, oats and wheat are indicated by the tabulated results of this work. The average yields of these crops on Experiment Station fields at Columbia and in different parts of the state are shown in Table 2.

*Many of the experiments reported in this bulletin were planned by M. F. Miller in 1906 and have been at various times under the direct charge of Professor Miller, H. D. Hughes, C. B. Hutchison, T. R. Douglass and J. B. Smith. Since 1916 the work has been carried on under the direction of W. C. Etheridge, chairman of the Department of Field Crops.
This bulletin, therefore, considers the following conditions and processes:

(1) Fertility of the Soil .................................................. 5
(2) Preparation of the Seed Bed ......................................... 7
(3) Method of Planting ..................................................... 8
(4) Time and Rate of Planting .......................................... 11
(5) Cultivation During the Growing Season .......................... 13
(6) Corn versus Grain Sorghums for Thin Uplands .................. 15
(7) Mixture of Corn and Other Crops ................................ 18

**CORN IN A CROPPING SYSTEM**

Crop rotation is the basis of continuous profitable farming on the same land. The practice of continuous cropping or planting the same field year after year to the same or similar crops, has probably done more than any other one thing in reducing the margin of profit secured from the corn crop.

The first principle of maintaining soil fertility is in seeding cultivated land to grass or clover, at frequent intervals, for meadow or pasture.

**Table 2.—Average Acre Yields of Corn, Oats and Wheat.**

(On Experiment Fields at Columbia, Maryville and Warrensburg)

<table>
<thead>
<tr>
<th></th>
<th>Columbia, Boone County</th>
<th>Maryville, Nodaway County</th>
<th>Warrensburg, Johnson County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Oats</td>
<td>Wheat</td>
<td>Corn</td>
</tr>
<tr>
<td>12 yrs.</td>
<td>10 yrs.</td>
<td>12 yrs.</td>
<td>6 yrs.</td>
</tr>
<tr>
<td>45.5 yrs.</td>
<td>30.4 yrs.</td>
<td>23.2 yrs.</td>
<td>61.2 yrs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Oats</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 yrs.</td>
<td>6 yrs.</td>
<td>5 yrs.</td>
</tr>
<tr>
<td>61.2 yrs.</td>
<td>48.5 yrs.</td>
<td>29.8 yrs.</td>
</tr>
<tr>
<td>28.3 yrs.</td>
<td>30.6 yrs.</td>
<td>14.6 yrs.</td>
</tr>
</tbody>
</table>

Corn, wheat, oats and soybeans are the most important crops for the greater part of the State. Where any or all of these crops are grown, grass or clover should be sown at intervals of three to six years, depending upon the conditions involved in each particular case.

The yield of corn more than the yield of any other crop is lowered by continuous cropping. In addition to the rapid depletion of soil fertility the physical condition of the soil becomes poor. Corn smut, root diseases and the attack of insects often develop from continuous cropping.

Corn naturally fits into a cropping system following sod and preceding oats or soybeans. While there are practical objections to the planting of sod land to corn, no other crop, with the exception of sorghum, is better adapted. Sod land being naturally dry, the crop is more subject to damage from drought than when planted on land that has been under cultivation for one or more years. In addition to the natural dryness of sod land, corn also suffers during a drought because of the relative rank growth which makes a greater demand for soil moisture. Experimental evidence indicates, however, that soil moisture is more efficient on fertile
soils than on poor soils. In other words, a pound of soil water will produce more dry matter in plant substance on fertile land than it will produce on soil relatively poor.

All arguments against a rotation following sod with corn cannot set the advantages gained by establishing a system providing sod in the cropping system.

**VARIETIES**

For the upland soils of North Missouri medium early maturing varieties are preferable. Reid’s Yellow Dent is one of the best of these varieties. Boone County White and St. Charles White are varieties recommended for the uplands of Central Missouri.

In the southern part of the state Commercial White is adapted to the upland soils. For the lowlands of Southeast Missouri, St. Charles White has proved best. For all bottom lands of the State, excepting the lowlands of the southeastern portion, Boone County White is generally recommended.

When early varieties, those maturing in from 100 to 115 days, are wanted, use Iowa Silvermine, Diamond Joe, or early maturing types of Calico or Bloody Butcher.

For silage purposes St. Charles White and Commercial White have proved superior to other varieties tested.

A thorough discussion of varieties is included in Missouri Experiment Station Bulletin 181.

**THE USE OF MANURE ON CORN**

The results of fifteen years experiments by the Department of Soils of this station on a large number of soil types in various sections of Missouri show an average yearly increase in yield of 10.34 bushels an acre, when 8 tons of manure were applied in a four-year rotation and plowed under before planting corn. No more manure was applied until the beginning of the next rotation.

The average annual increase of crops following corn in the rotation have been, oats 4.59 bushels, wheat 4.73 bushels, and clover hay 808 pounds. It will be seen from these figures that the effect of the manure was by no means confined to the corn crop. It is usually most convenient, however, to apply manure before corn so that it can be plowed under. Less of the fertility supplied by the manure is lost if this is done than if the manure is applied as a top dressing. However, it is often good practice to top-dress wheat with manure where clover or grass is to follow. It is better to plow under coarse, fresh manure several weeks before the corn is planted, as this gives time for decay to begin and there will be more plant food available when the young corn needs it.

Manure may be applied to corn at almost any rate up to 16 tons an acre with profitable results. An application of this sort, however, is possible only if a large amount of feed is purchased. The average farm can not produce more than enough manure to apply eight tons an acre once
in a four year rotation, or an average of two tons an acre a year to the cultivated land. This amount can be applied only if the most careful methods of handling manure are used.

Manure in itself is not a complete fertilizer as compared with the needs of the crops and the soil, for the percentage of phosphorus is low. This may be corrected by adding 25 to 40 pounds of acid phosphate to each load of manure before applying.

**FERTILIZERS FOR CORN**

When the supply of barnyard manure is limited it is often profitable to apply commercial fertilizer to corn. In the experiments conducted on the soil experiment fields an application of steamed bonemeal at the rate of 150 pounds an acre, applied with a fertilizer drill ahead of the corn planter, has given an average increase in yield of 3.59 bushels of corn and 5.45 bushels of oats following the corn the next year. Acid phosphate has given results similar to steamed bonemeal when tested on the same fields.

On medium to thin lands where some manure is used it is usually good practice to apply about 150 to 250 pounds of acid phosphate or bonemeal with a fertilizer drill ahead of the corn planter. On very thin lands and especially where little manure is returned and few legume crops grown a mixed fertilizer containing 2 or 3 percent nitrogen, 10 to 12 percent available phosphoric acid and 2 or 3 percent potash may be used instead of the acid phosphate or bonemeal. Fertilizers give their best results on corn in seasons of normal rainfall. During dry years they may cause the corn to fire and produce little or no increase in the yield of grain.

In some parts of Missouri it is common practice to apply fertilizer in the hill or row with an attachment to the corn planter. When used in this way the fertilizer should be applied at only 75 to 100 pounds to the acre. During seasons of abundant rainfall this method will yield good returns, but in dry years there is more danger that the fertilizer may cause the corn to fire than when it is applied ahead of the planter with a fertilizer drill. The effect on the following crop will also be less than if the fertilizer is applied with a fertilizer drill.

In general the fertilizing of corn may be considered a temporary means of increasing the immediate crops. It has little effect in building up the soil except that the phosphorous content may be slightly increased if large quantities of high phosphatic fertilizers are added. In any system of fertilizing corn the other crops in the rotation should always be considered, for the increased yields of these may greatly increase the profit from the fertilizer. Fertilizer should be used with a good system of crop rotation which returns an abundance of organic matter and manure to the land and which utilizes the best methods of cultivation and soil management. That is, fertilizers should be used to help raise the general level of crop yields; but they should not be depended upon to increase or even to maintain yields, unless other provisions are made for maintaining the organic matter and nitrogen of the soil.
PLOWING FOR CORN

Fall plowing usually is advisable when the land is not inclined to wash badly. Spring plowing should be practiced exclusively where land washes during the winter months. Land deeply fall plowed is less subject to erosion than when plowed very shallow.

Fall plowing has many advantages other than reducing the amount of spring labor. Whenever practicable, sod land should be broken in the fall. It causes a more complete decay of all plant growth turned under, together with the decay of grass roots. Disking before plowing is recommended. Fall disk ing and plowing of sod land reduce the danger that corn yields will be cut by drought in the following season. Another factor favoring fall plowed sod land is the control of wireworms and cut worms. Their attack is always more noticeable following sod, especially in seasons when the weather is continually cool and moist the first two weeks after the corn is up. Fall plowing followed by ‘freezing weather helps materially in the control of these pests.

Fall plowing not only provides more time for thorough seed bed preparation in the spring, but makes possible the preparation of a good seed bed with less labor, because of the effects of freezing and thawing. Fall plowing in the place of spring plowing usually will reduce the labor of preparing the seed bed by at least one double disk ing.

Depth of Plowing.—The proper depth of plowing land for corn depends largely upon the nature of the soil and subsoil, and the depth of former plowing. Plowing 6 to 8 inches deep is recommended as a general practice. Plowing always at one depth tends to pack the soil below the furrow depth. When it is desired to deepen a shallow soil by plowing, the depth of plowing should be increased very slightly each year. Do not throw out several inches of new soil at one time for this may result in decreased yield of the crop. This decrease will be more noticeable when the ground is plowed in the spring. The effect will also depend largely upon the nature of the soil and subsoil.

SEED BED PREPARATION

In preparing the land for planting the ultimate object is weed control. After fall plowing it is well to let the land lie in its rough condition as long as possible up to the final preparation for planting. But when land is plowed in the spring it should be harrowed soon afterward. There are two distinct advantages of this practice (1) the harrowing fills in the spaces between the furrow slices and thus checks the evaporation of moisture and (2) it levels the surface and makes disking much easier and more effective. However, final preparation of spring-plowed land should also wait until just before planting. The great benefit in this practice is the destruction of early grass and weeds which are so difficult to clean out at the early cultivation of the crop. Planting on thoroughly clean land is an important step toward a successful crop.

When the land is disked but once, disking should cross the direction of plowing. In harrowing go across the disking or at an angle to the direction of disking. This method provides a more uniform seed bed.
level seed bed is essential, especially if the ground is only moderately loose, as it results in a more uniform depth of planting.

In the case of sod land double disking with cross disking is usually necessary to put the ground in good shape for corn. The amount of work will always depend upon the time of breaking and the sodded condition of the soil. Thorough working of the surface before planting, thus enabling better covering of the seed, will always reduce the damage done by field mice, crows and other birds. Following the planter with a harrow will also help materially.

METHODS OF PLANTING

Through the greater part of the corn belt corn is surface planted on ground prepared by fall or spring plowing. The listing of corn is a practice confined largely to the western section of the corn belt in regions where moisture is the limiting factor in crop production.

Listing is not recommended as a general practice for Missouri. It is, especially, not advisable through the greater part of Northeast Missouri and in other sections where the land is flat and none too well drained. On such land listing increases the danger that the seed will rot in the ground or that the young crop will be drowned out after it comes up.

In sections where the soil is relatively shallow, listing is not advisable, for it would result in planting the corn in or near the subsoil. But in the extreme Northwestern part of the State, designated in general by Atchison, Nodaway, Holt, Andrew, DeKalb, Gentry, Harrison and Worth counties, there is reason for believing that where land is well drained, listing is better than surface planting. At Maryville, in Nodaway county, tests of listing covering a nine-year period have been conducted by the Missouri Experiment Station in co-operation with the Northwest Missouri State Teachers College, with excellent results. These results are reported in Table 3.

As an average for the nine years single listing has increased the yield 12.6 bushels per acre over plowing and surface planting. The use of furrow openers in surface planting, by which means the seed is planted in shallow furrows, increased the yield 7.4 bushels per acre over ordinary surface planting. Double disking ahead of the lister has not paid for the labor involved. Double disking has been inferior to single listing to the extent of 6.6 bushels decrease per acre.

During each of the nine years single listing has given a better yield than the average of the other four methods. Except for the seasons of 1911, 1915, and 1916 single listing has given larger yields than any other methods, being for two of these years slightly lower in yield than where furrow openers were used on plowed land. A study of the rainfall table (see Table 4) shows that during the years of 1915 and 1916 more rain fell during the months of June to August inclusive than for this period in any of the remaining seven years. Moisture was especially plentiful in 1915 during the period June to August.

The relatively low yields from double listing can be explained, in part at least, by the condition of the seed bed. The treatments were conducted each year on land that had been in corn, surface planted the year before.
### Table 3.—Yield of Corn as Determined by the Method of Preparing the Seed Bed.
(Maryville, Nodaway County)

<table>
<thead>
<tr>
<th>Method of preparing seed bed</th>
<th>Yield in bushels per acre</th>
<th>9-year Avg.</th>
<th>Avg. increase over surface planting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1911</td>
<td>1912</td>
<td>1913</td>
</tr>
<tr>
<td>Ground plowed, crop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>surface planted</td>
<td>49.9</td>
<td>62.8</td>
<td>14.5</td>
</tr>
<tr>
<td>Ground plowed, crop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>planted in shallow furrows</td>
<td>55.6</td>
<td>76.5</td>
<td>18.6</td>
</tr>
<tr>
<td>Double listed</td>
<td>56.9</td>
<td>73.0</td>
<td>28.2</td>
</tr>
<tr>
<td>Double disked, single listed</td>
<td>67.4</td>
<td>75.5</td>
<td>36.7</td>
</tr>
<tr>
<td>No disking, single listed</td>
<td>60.3</td>
<td>80.0</td>
<td>43.1</td>
</tr>
<tr>
<td>Average</td>
<td>58.0</td>
<td>73.5</td>
<td>28.2</td>
</tr>
</tbody>
</table>

### Table 4.—Showing Inches of Rainfall for Months of June, July, and August.
(Maryville, Nodaway County)

<table>
<thead>
<tr>
<th>Year</th>
<th>June (weeks)</th>
<th>July (weeks)</th>
<th>August (weeks)</th>
<th>Total Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>4th</td>
</tr>
<tr>
<td>1911</td>
<td>.00</td>
<td>.65</td>
<td>.38</td>
<td>.03</td>
</tr>
<tr>
<td>1912</td>
<td>.29</td>
<td>.17</td>
<td>.34</td>
<td>.00</td>
</tr>
<tr>
<td>1913</td>
<td>.49</td>
<td>.00</td>
<td>.41</td>
<td>1.90</td>
</tr>
<tr>
<td>1914</td>
<td>.06</td>
<td>2.68</td>
<td>.27</td>
<td>.00</td>
</tr>
<tr>
<td>1915</td>
<td>.54</td>
<td>1.46</td>
<td>1.43</td>
<td>.19</td>
</tr>
<tr>
<td>1916</td>
<td>.57</td>
<td>.34</td>
<td>3.02</td>
<td>.08</td>
</tr>
<tr>
<td>1917</td>
<td>1.06</td>
<td>1.60</td>
<td>.04</td>
<td>4.22</td>
</tr>
<tr>
<td>1919</td>
<td>2.25</td>
<td>1.65</td>
<td>.94</td>
<td>.60</td>
</tr>
<tr>
<td>1920</td>
<td>.32</td>
<td>.00</td>
<td>.05</td>
<td>.94</td>
</tr>
</tbody>
</table>
The stalks were not pastured and considerable plant residue and trash was present each spring. Through double listing this plant residue was only partly covered. This left the soil extremely loose and porous and the crop was probably more subject to damage from drought. It also interfered materially with cultivation, even to the extent of reducing the stand by the occasional loosening or tearing out of hills of corn.

This series of experiments was partly duplicated during the years 1917 to 1920 in co-operation with the Central Missouri State Teachers' College at Warrensburg in Johnson County. While the results shown in Table 5 are not consistent enough to warrant general recommendations, the

Table 5.—Yields of Corn Surface Planted With and Without Furrow Openers.
(Warrensburg, Johnson County)

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>Bushels per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1917</td>
</tr>
<tr>
<td>Surface planted without furrow opener</td>
<td>40.1</td>
</tr>
<tr>
<td>Surface planted with furrow opener</td>
<td>52.2</td>
</tr>
</tbody>
</table>

The use of furrow openers increased the yield 3.9 bushels per acre over that of ordinary surface planting. Moisture is without question the most important limiting factor in corn production over much of Northwest Missouri. The soil is deep, fertile, and generally well drained. Under such conditions corn grows extremely rank. Dry periods, though often short in duration, seriously effect the yield of corn.

Fig. 1.—Comparative Yields of Corn Surface Planted and Listed, at Maryville in Nodaway County.
Listed corn is somewhat reduced in stalk development and leaf area. For this reason and probably for others which are not understood, listed corn is able to withstand drought better than surface planted corn. In addition, listed corn is less inclined to blow down or be broken off after earing.

In general, rainfall affects the relative production of listed corn and surface planted corn. A study of Tables 4 and 6 and figure 1 will show this correlation. It is best illustrated during the seasons 1913 and 1915. In 1913 listed corn gave an increase of 28.6 bushels while in 1915 the increase over surface planting was only 4.1 bushels. The total rainfall during the months of June to August was only 8.8 inches in 1913, and for the same period in 1915, 31.0 inches. Considering the rainfall for these years from April to August in 1913, 14.9 inches fell while in 1915 there was a total of 38.6 inches.

**Table 6.—Yields of Corn from Two Methods of Planting, Together With Inches of Rainfall During Growing Season.**
(Maryville, Nodaway County)

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
<th>1915</th>
<th>1916</th>
<th>1917</th>
<th>1919</th>
<th>1920</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>No disking, land single listed</td>
<td>60.3</td>
<td>80.0</td>
<td>43.1</td>
<td>58.1</td>
<td>45.2</td>
<td>59.2</td>
<td>84.2</td>
<td>91.9</td>
<td>55.9</td>
<td>64.2</td>
</tr>
<tr>
<td>Land plowed, crop surface planted</td>
<td>49.9</td>
<td>62.8</td>
<td>14.5</td>
<td>44.9</td>
<td>41.1</td>
<td>46.3</td>
<td>75.0</td>
<td>78.5</td>
<td>51.7</td>
<td>51.6</td>
</tr>
<tr>
<td>Difference</td>
<td>10.4</td>
<td>17.2</td>
<td>28.6</td>
<td>13.2</td>
<td>4.1</td>
<td>12.9</td>
<td>9.2</td>
<td>13.4</td>
<td>4.2</td>
<td>12.6</td>
</tr>
<tr>
<td>Total inches rainfall June 1 to Aug. 30</td>
<td>5.7</td>
<td>6.3</td>
<td>8.8</td>
<td>6.3</td>
<td>31.0</td>
<td>10.8</td>
<td>10.7</td>
<td>8.8</td>
<td>5.3</td>
<td></td>
</tr>
</tbody>
</table>

For the season of 1912 listed corn gave an increase of 17.2 bushels. The total rainfall for the summer months was only 6.3 inches. In some seasons, for example the season of 1920, the relations are not so consistent. The difference in yield favoring listed corn was only 4.2 bushels yet the total rainfall was comparatively light; especially during the last three weeks in June and for the month of August. This can be explained in part by the relatively thin stand on the plots for this season. Under less than normal stand, the effects of dry weather would not be so noticeable.

**TIME, MANNER AND RATE OF PLANTING**

Corn in Missouri ordinarily is planted too early for best yields. Lower yields from early planting may result from (1) poor stands due to rotting of the seed and attacks from wireworms and cutworms, and (2) an early, rank growth of weeds, which is seldom completely cleaned out.

There are, however, two practical reasons in favor of early planting. The first is the convenience of labor. Where large acreages are to be planted it is necessary to start early in time to finish planting at a seasonable date. The second one is that late planted corn is often caught by
dry periods at a critical stage in its development during silking and tassel ing. Corn planted earlier may escape partly or entirely such dry peri ods. At this stage corn is affected more by dry periods and hot winds than at any other time, resulting in firing the tassel, poor pollination, and a general check in shooting and ear development. Many of the so called barren stalks are caused by dry weather, thick planting or a combination of both.

Late planted corn is also affected more by the attack of corn ear worms than corn planted earlier. However, all reasons in favor of early planting will not warrant planting so early that stands are reduced or that the crop cannot be kept clean.

Through the sandy soils of Southeast Missouri, the Ozark section, the Ozark border, and the flat and rolling prairies of Southwest Missouri, early planting of corn is necessary for the best success in average years. These soils are naturally dry and failures from drought are not uncom mon. Planting two weeks later than the average date often will result in practically complete failures. Through the central and northern part of the State the soils do not dry out so quickly, especially along the Missouri River and in the northwest section. In these areas extremely early planting is seldom warranted.

In general, corn on upland should be check-rowed and on rich, moist bottom land drilled. Where land will stand a heavy rate of planting, more corn can be raised from drilled corn than from checked corn. This is partly because (1) more good ears can be produced in drilled corn than in corn checked and (2) under ordinary conditions the roots are dam aged more in cross cultivation. However, when corn is drilled one must consider the difficulty in weed control, especially in backward seasons.

The common rate of planting is three kernels checked every three and one-half feet in rows 3 feet 5 inches to 3 feet 8 inches apart. When the crop is drilled the quantity of seed used is about the same. A heavier rate is not to be recommended for most corn land in the State except where the crop is intended for silage. On rich, moist, bottom soils typified by the Missouri river bottoms a heavier rate, an additional stalk every 3.5 feet in the row, will usually result in greater yields, especially as a silage crop. Where corn is planted very thick, however, it should always be drilled.

On the thinner uplands of Missouri corn is easily affected by drought, and a standard rate of two plants to every 3.5 feet in the row, checked or drilled, will yield as much and usually more corn per acre than a heavier planting. This applies especially to the Ozark region, the Ozark border, and the southwest level prairies of the State.

At the Missouri Experiment Station for the seasons of 1918, 1919 and 1920 checked corn 2 stalks per hill averaged 2.3 bushels per acre more than a 3-stalk rate. The results are reported in Table 7.

**CORN CULTIVATION**

Corn is cultivated primarily to kill weeds and at the same time to keep the soil receptive to rainfall. On thin soils or where there is a ten dency for the soil to run together and become hard and baked, cultiva-
tion also helps to hold moisture. In general, however, where extra culti-
vations are not necessary for weed control, it is doubtful if the results se-
cured will pay for the extra labor involved. This is true especially on all
soils which could be classed as above the average in fertility.

Late cultivation after corn is normally laid by will rarely pay. Ex-
tra cultivations are usually done with a one-horse cultivator harrow, single
shovel, or mower wheel harrow. If in these extra cultivations the ground
is stirred deeply the actual result will more often be to decrease the yield
than to increase it.

Corn develops its principal feeding roots in the top six to seven inches
of soil. These roots develop rapidly as the plants advance in growth, and
by the time corn is in full tassel have extended through the soil between
and in the row. Any cultural operation which interferes with this de-
velopment may materially reduce the yield of the crop.

Table 7.—Yields of Corn Planted at Different Rates.
(Columbia, Boone County)

<table>
<thead>
<tr>
<th>Rate of planting</th>
<th>Check-rowed</th>
<th>Check-rowed</th>
<th>1918</th>
<th>1919</th>
<th>1920</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-rate</td>
<td>14.4</td>
<td>10.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-rate</td>
<td>47.8</td>
<td>47.0</td>
<td>69.0</td>
<td>66.3</td>
<td>43.7</td>
<td>41.4</td>
</tr>
</tbody>
</table>

Deep cultivation should be avoided late in the season, especially when
corn is being normally plowed the last time. The effects of deep cul-
tivation will more often be noticeable during periods of drought. Deep,
late cultivation followed by extremely dry weather may often reduce the
yield of corn 10 to 15 percent, especially if the drought comes at a
critical time in corn development—silking and tasseling.

The effect of deep cultivation on the yields of corn is indicated in
Table 8 which shows the importance of shallow tillage. In these experi-
ments, carried on at four outlying fields in the State, land previous to cul-
tivation was treated in exactly the same manner. Shovel type of cultiva-
tors were used in these experiments. All plots were cultivated four times
except the plots receiving late culture, which were cultivated six times.
For both shallow and late cultivations the soil was stirred only deep
enough to keep down weeds. On the deep cultivated plots the soil was
stirred to an average depth of five inches. On the surface scraped plots
no cultivators were used; the weeds being controlled by very shal-
lo-hoeing.

The average yields for the ten years at all the four fields brings out
four practical points in regard to corn culture: (1) cultivation is primarily for
the purpose of weed control (2) deep cultivation reduces the yield (3)
late cultivation will ordinarily not pay for the labor involved and (4) av-
erage cultivation, even though shallow, causes considerable injury to corn
roots, resulting in reduced yields.

Nearly 10 bushels greater yield was obtained by keeping the weeds
down by hoeing, as compared to shallow cultivation. The practical ap-
plication of this result may be found in the use of weeder knives in the place of shovels during the later stages of corn growth. Six and one-half bushels increase was secured from shallow culture, over cultivating deeply.

At the Shelbina field, ridging the land was practiced in comparison with the shallow, late and deep cultural operations, reported in Table 8. An average acre yield for three years of 18.6 bushels was secured. This was four bushels per acre less than on the shallow cultivated plots.

These results are consistent with those from cultural experiments conducted in other states. For example, at the Illinois Station for a period of five years, an increase of 6 bushels resulted from shallow cultivation, as compared to deep cultivation.

**Table 8.—Effects of Different Methods of Tillage on the Yield of Corn.**
(Summary of Results from Four Fields)

<table>
<thead>
<tr>
<th>Method of cultivating</th>
<th>Number of cultivations</th>
<th>Yield in bushels per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shelbina (Shelby Co.) 3 years</td>
<td>Maryville (Nod'w'y Co.) 3 years</td>
</tr>
<tr>
<td>Shallow</td>
<td>4</td>
<td>22.5</td>
</tr>
<tr>
<td>Late</td>
<td>6</td>
<td>21.4</td>
</tr>
<tr>
<td>Deep</td>
<td>4</td>
<td>21.1</td>
</tr>
<tr>
<td>Surface scraped</td>
<td>none*</td>
<td>58.9</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>21.7</td>
</tr>
</tbody>
</table>

*No cultivation; but the plot was kept clean by scraping the surface with a hoe whenever the other plots were cultivated.

**WEED CONTROL**

Crop rotation is the first step in weed control. Since one of the most important items in the cost of corn production is the cultural operations, any methods which will reduce the labor costs of keeping corn free of weeds will materially increase the crop profits.

Certain weeds, due to their habits and time of growth, are naturally associated with cultivated crops. Crab grass, yellow and green foxtail, bull nettle, butter print, pigweed, morning glory, and cocklebur are the principal bad weeds in corn. These weeds are always to be found in greater numbers in land grown year after year to corn. Through a systematic alternation of corn, small grains and grass much progress can be made in the control of weeds. Sod land planted to corn can be kept clean with less labor than land long under cultivation.

For the season, weed control is best secured by planting on a seed bed freshly prepared ahead of the planter. This gives the corn an opportunity to start even with the weeds, if not ahead of them, and makes it possible to clean the corn by the first cultivation. Extremely early plant-
ing usually results in difficulty in cleaning corn. Certain weeds germinate promptly and grow more rapidly under cool, moist conditions.

The harrow is one of the best implements in corn cultivation. Corn may be harrowed before it is large enough to cultivate, and while the weeds are yet small. Harrowing also breaks any soil crust that may have been formed and serves to make the soil drier and warmer on the surface, stimulating the growth of the corn. Harrowing while corn is small reduces the damage done by field mice, cutworms, wireworms and birds. Any reduction in stand by harrowing is easily offset by these advantages gained. The harrow should always be set with the teeth slanting back rather than straight.

When corn is planted on first year sod the disk type of cultivator is more desirable than the shovel types. This is true at least for the first and second cultivations, especially if the ground is well set with grass roots.

In backward seasons or where weeds have made a large growth, corn can be more easily cleaned with the disk cultivator. Ground can be cultivated with this implement when too wet for the shovel cultivator. The corn should be "barred off," getting as close to the plants as is possible. At this time corn has not developed an extensive root system and there is always sufficient moisture to prevent the soil from drying out. There is no danger in retarding the growth of the plants.

For the second cultivation the disks should be set to throw the soil back, giving enough "set" to cover weeds between the hills. If the corn has been checked, the second cultivation may also "bar off," crossing the first and breaking out the sections between the hills. After the two first cultivations either type of cultivator is equally satisfactory.

Due to the inefficiency in maintaining two complete sets of cultivators, the common practice is to use either the disk or shovel type exclusively. Where all cultivations are made with the disk type care should be used to prevent excessive ridging of land by the time the corn is being worked the last time. The land should be left as near level as possible. The practice of ridging corn is common, especially on the less rolling and poorly drained soils of Northeast and Southwest Missouri. The results obtained in securing better drainage during early spring will not offset the damage done the plants during the drier periods of summer.

On stumpy or rocky land, the four-shovel type of cultivator is in more common use. Whenever practicable, however, the six-shovel implements are to be preferred. The land can be stirred more effectively without cultivating deeply and without the necessity of ridging.

**CORN OR SORGHUM FOR THIN UPLANDS**

On much of the thin, dry uplands of the Ozark section corn is a difficult crop to grow successfully, except in especially favorable seasons. Over this section, as well as the uplands of the Ozark border and the level prairies of Southwest Missouri, there is reason for believing that grain sorghums are generally better than corn for a grain crop. When cured forage is desired the sweet sorghum will produce more tonnage and a better quality of feed than corn will produce.
The sorghums are extremely drought resistant. They will live through periods so dry that corn would be ruined for seed or forage, and when the drought is broken, they will go into a vigorous growth. They will make fairly good yields on poor land.

Comparative yields of corn and sorghums were secured during the seasons 1919 and 1920 at Columbia, Boone County, and at Cuba, Crawford County. Additional yields were secured during the seasons 1917, 1918 and 1919 at Warrensburg, Johnson County. The results are shown in Tables 9, 10 and 11.

The results secured at Cuba, Crawford County, as shown in Table 10, are an indication of what may be expected in yields of these crops. The soil on which the experiments were conducted will not make a good crop

![Fig. 2.—A field of Grain Sorghum in Crawford County (Photographed at Second Cultivation.)](image)

Table 9.—Yields in Seed, Green Forage, and Cured Forage of Corn, Grain and Sweet Sorghums.
(Columbia, Boone County)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Bushels of grain per acre</th>
<th>Tons of green forage per acre</th>
<th>Tons of cured forage per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>50.6</td>
<td>62.5</td>
<td>56.6</td>
</tr>
<tr>
<td>Kafir</td>
<td>66.8</td>
<td>26.0</td>
<td>46.4</td>
</tr>
<tr>
<td>Milo</td>
<td>65.0</td>
<td>13.8</td>
<td>39.4</td>
</tr>
<tr>
<td>Feterita</td>
<td>56.6</td>
<td>15.9</td>
<td>36.3</td>
</tr>
<tr>
<td>Sweet Sorghum</td>
<td>50.1</td>
<td>15.7</td>
<td>32.9</td>
</tr>
</tbody>
</table>
of corn in the average season. The season of 1919 was so dry that corn was practically a complete failure. The season of 1920 was a good one for corn. By comparing the yields of these two seasons it will be seen that corn was affected by the dry season of 1919 much more than were the sorghums. As a comparison between kafir and corn for the two years, kafir yielded nearly four times more grain; twice as much green forage, and one-third more cured forage per acre. Kafirs are the best among the grain sorghums tested.

**Table 10.—Yields in Seed, Green Forage and Cured Forage of Corn, Grain Sorghum and Sweet Sorghum.**

(Cuba, Crawford County)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Bushels of grain per acre</th>
<th>Tons of green forage per acre</th>
<th>Tons of cured forage per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>1.5</td>
<td>13.8</td>
<td>7.7</td>
</tr>
<tr>
<td>Kafir</td>
<td>22.7</td>
<td>33.0</td>
<td>27.9</td>
</tr>
<tr>
<td>Milo</td>
<td>10.6</td>
<td>16.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Feterita</td>
<td>9.4</td>
<td>8.7</td>
<td>9.1</td>
</tr>
<tr>
<td>Sweet Sorghum</td>
<td>14.6</td>
<td>27.9</td>
<td>21.3</td>
</tr>
</tbody>
</table>

**Table 11.—Yields in Cured Forage of Corn, Grain and Sweet Sorghum.**

(Warrensburg, Johnson County)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Tons of cured forage per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1917</td>
</tr>
<tr>
<td>Corn</td>
<td>2.6</td>
</tr>
<tr>
<td>Kafir</td>
<td>1.1</td>
</tr>
<tr>
<td>Milo</td>
<td>1.8</td>
</tr>
<tr>
<td>Feterita</td>
<td>1.1</td>
</tr>
<tr>
<td>Sweet Sorghum</td>
<td>4.4</td>
</tr>
<tr>
<td>Sudan grass</td>
<td>2.6</td>
</tr>
</tbody>
</table>

The tests at both Columbia and Warrensburg were conducted on land better for corn than the average uplands of these two sections. At Warrensburg only forage yields were determined while at Columbia yields of both forage and grain were measured. Tables 9 and 11 indicate that on land of this type sorghums are inferior to corn in yield of grain but superior in forage yields.

Based on yields secured at the three fields, sweet sorghums are superior as a forage crop to either corn or kafir the best of the grain sorghums. At Cuba, sweet sorghum yielded one-third more cured forage and twice the green forage yielded by corn. At Columbia the yield of sweet sorghum in cured forage was about equal to that of grain sorghum and greater than that of corn. In green forage the tonnage was double that
of either grain sorghum or corn. At Warrensburg sweet sorghum yields in cured forage were twice as large as the yields of either corn or sorghum.

From results so far secured, sorghums are to be recommended for thin uplands of South Missouri, growing the grain sorghum for a grain crop and the sweet sorghum for forage. The production of corn should be limited largely to the first and second creek and river bottomlands of these sections and to the more productive uplands.

Where sorghums are grown for grain as a substitute for corn the kafirs are preferable to feterita or milo. They make a better yield, ripen more uniformly, and shatter less. The milos, especially the dwarf varieties, are not easily harvested. The chief objection to feterita is its heavy production of suckers which results in an unevenly ripened crop. When allowed to become over ripe feterita shatters badly. Among the kafirs, Standard Blackhull, Sunrise and Dawn are probably the best varieties for Missouri.

When the crop is to be used for forage, either green or cured, the sweet sorghums are preferable to either corn or grain sorghum. The Amber, Orange and Honey are the best varieties. The varieties are named in order of their time of maturity.

**CATCH CROPS IN CORN**

The practice of using any crop other than rye as a catch crop in corn is not to be recommended except on bottom land well supplied with available moisture. At the last corn cultivation, the usual time of seeding catch crops in corn, as rye, rape, cowpeas or soybeans, the weather is usually dry and hot. The ground is shaded by the corn and frequently there is not enough moisture to give uniform germination of the seed. Sufficient growth from the catch crop to warrant the practice, can only be secured in rare seasons when there prevails a period of cool moist weather following such planting. At the Missouri Experiment Station, the returns from broadcasting soybeans in corn at the last cultivation have never been large enough to pay for the cost of the seed.

**Corn and soybeans.**—The planting of soybeans with corn is becoming more popular each season. The use of cowpeas with corn is an old practice, especially over the southern part of the corn growing region. Soybeans give better results because they produce more seed and are fully equal to cowpeas in yields of forage. Where soybeans are planted with corn, both crops should always be planted at the same time.

Corn and soybeans cannot be mixed and planted from the same box. Soybeans are best planted with a pea and bean attachment on the corn planter, which can be secured for all standard planters. These attachments are fixed to the planter frame and deliver the seed from a separate box into the same dropping channel as that of the corn. With this arrangement soybeans can be drilled, or dropped in the hill with corn where the crop is checked. The planter should be set to drop an average of two soybeans for every two to three kernels of corn. Four to six pounds of soybeans are required per acre, depending upon the size of the seed. When soybeans are planted in corn, do not plant too early or too deep. Early and deep planting often result in poor stands of soybeans.

Soybeans are planted in corn for pasturing with lambs in the stand-
ing corn, for hogging both crops off or for using the combined crop for silage. Where the combined crop is used for silage some of the beans may shatter. Much of this loss can be recovered by pasturing the corn stubble with hogs.

The exact value of hogging off corn and soybeans, using the soybeans as a substitute for tankage or other similar concentrates, has not been fully determined. The Missouri Experiment Station has, however, made a study of the effect of soybeans on the yield of corn when the two crops are combined.

Soybeans planted in corn decrease the yield of the corn. The amount of decrease depends in general upon three things, (1) rate of planting both

corn and soybeans, (2) soil fertility, and (3) relative amount of moisture during the growing season. In general a cut in the corn yield of from 2 to 7 or 8 bushels per acre may be expected, depending upon the degree of one or more of the above conditions. However, the soybeans may themselves yield 4 or 5 bushels of seed, and hence may abundantly compensate for any reduction in yield of corn which they cause. This question can be settled only by direct feeding experiments, which are now being conducted by the Missouri Experiment Station.

**Corn and cowpeas.**—The combination of cowpeas and corn is similar in every way to corn and soybean combinations. Their effects on corn

**Fig. 3.**—Soybeans in Corn Should be Seeded at the Same Time the Corn is Planted.
yields are also similar to that of soybeans. At the Shelbina field in 1914 cowpeas planted in corn decreased the corn yield 2.24 bushels per acre. At the Morely field in 1913 the decrease was 6.6 bushels. On the latter field the soil is quite sandy and readily subject to drought.

Cowpeas in corn will compare favorably with soybeans only when the crop is to be used for silage. For other purposes soybeans are more satisfactory.

**Corn and rape.**—Rape is not well suited for planting in corn. It is a cool season plant which gives its best results from either early spring or late summer planting. Average corn planting time in the spring is too late to sow rape for best results. The practice of seeding rape in corn at the late cultivation is, under average conditions not practical because in the usual dry, hot weather at that time of the year, the rape will rarely germinate and grow well. Considerable forage for late summer and fall pasture can be secured by seeding rape along the fences in the turning rows.