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Cotton Culture

By

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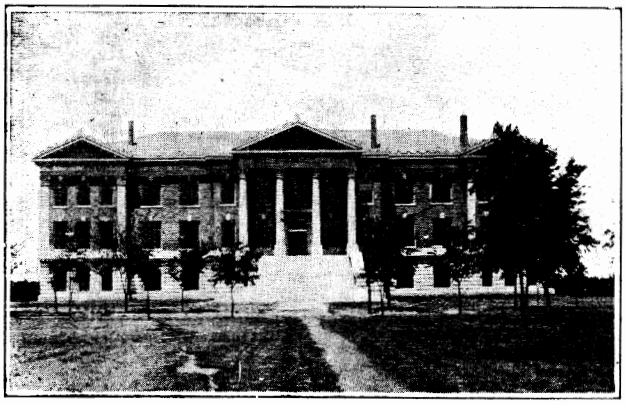

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Oklahoma Experiment Station

COTTON CULTURE.

Cotton is a banner crop in Oklahoma. This crop has been tested for several years in succession in the two territories, and the practical grower has reached the conclusion that cotton can be cultivated with profit in the new state. While it is true that the average yield per acre in this state is comparatively low and the cost of production on many farms equals or perchance exceeds the gross returns obtained from the land under cultivation, at the same time the optimistic grower, who is, without doubt, intensely interested in the improvement of this plant, knows full well that his output can be increased materially through the application of simple, business methods. These plans are not complex, nor are they beyond the grasp of the novice; but they can be appropriated and put into practice on the five or ten acre field as well as on the more extensive areas. Every cotton grower will concede the fact that the cultivation which the average crop receives does not reach the proper standard, and if some modification in our general system could be adopted better yields would be reported. Many of our soils are being depleted of their fertility, hence the stores of plant food do not meet the requirements of the crop. A further reduction in the yield of cotton may be prevented by keeping the soil in a productive condition. Legumes should be used in the crop rotation, and farm-yard manure should be applied systematically and judiciously. The selection of good seed is a matter of some importance. If a given plant possesses superior productive qualities, and these desirable characteristics are transmitted to the progeny, it is clear that some advancement may be made by selecting plants from this group as foundation material for future work. The plant kingdom offers many inducements in this line of research to the inquiring student. Within the past decade many changes have been wrought in that wonderful southern plant, "King Cotton;" and basing our judgment upon the most conservative estimates which have been submitted, it will be a safe matter to predict that more phenominal changes are in store for the breeder of the immediate future.

Although the cotton crop in Oklahoma does not measure up with the Indian corn plant, so far as the acreage is concerned, yet this plant is of sufficient economic importance to demand some study at the hands of the grower. Furthermore, there are questions associated with the culture of cotton which should be answered by the trained investigator and the enormous values represented in this one staple certainly justify some expenditure of money in the collection of data through the medium of the State Experiment Station. Maize is known

as the great food crop of the state because in our teeming cribs of yellow and white grain sustenance is found for man and beast. On the other hand, cotton is regarded as our money crop. The cotton crop serves a two-fold purpose. The fine fiber is passed through the loom, and the finished product is in turn used as wearing apparel; the seed is taken to the cotton oil mill, and when the process of manufacture is complete, cotton seed meal is purchased by the live stock man as an adjunct to his supply of concentrates; and the cotton oil becomes an article of trade. A market has been developed, a demand has been created; and it is reasonable to suppose in these days of expansion, that our market facilities will be extended, and the demand will increase. Oklahoma will thus be called upon to produce larger supplies of fiiber and cotton oil. New areas will undoubtedly be available for cotton culture as the state develops; and growing demands may be met with the increase which is obtained from the newly broken fields. However, as soon as the native sod has yielded to the pulverizing influence of the plow, and new sections are no longer available, an increase in production can be secured, not by doubling the cultivated area but through the introduction of better systems of soil and crop management. The average yield per acre obtained from the Oklahoma farms during the six year period, commencing with 1895 and ending with 1900, was .46 of a bale; the Indian Territory reported a return of .51 of a bale per acre for the same crop seasons. If our lands produce one-half of a bale per acre while in their virgin state, it will be a safe proposition to predict that much lower yields may be expected when the mechanical condition of the soil becomes impaired, and its producing power is reduced perceptibly. In the older states of this country, a continuous system of cropping was practiced during the opening years of this century. Good crops were secured for a time, then a decline in fertility was observed, and abandoned farms resulted in those cases where no attention was given to the question of soil improvement. The same conditions have been experienced on the rich farms of the middle west and if the Oklahoma farmer fails to read the signs of the times, his profits will eventually become so small that he will be compelled to take up some other business, The agricultural history of the east should not be duplicated in the southwest. Our resources are substantial, but they should not be despoiled. It is possible to maintain the productive capacity of the soil, and every energy ought to be turned in that direction. The farmers of Oklahoma are the guardians of the wealth of this state and in order that they may be able to commit this trust without stain to future generations, soil impoverishment should be checked as soon as the first furrow is turned on the new homestead.

CLIMATIC CONDITIONS.

In presenting experimental data, especially with reference to crop production, the temperature and rainfall of the section in question should be given some consideration. The cotton plant requires a liberal supply of moisture during the growing and fruiting periods, and comparatively dry weather is desirable throughout the harvest season. A wet, cold spring retards the growth of the crop and prevents early maturity. An excessive supply of moisture, accompanied by warm weather, will produce an abundant stalk and thus may exert a detrimental influence on the formation of fruit. Cotton is a warm weather plant; hence, the temperature should be such during the growing season that the plant will make a reasonably strong and rapid growth. In this section the average annual precipitation for the five year period commencing 1896 and ending 1900 was 33.68 inches as compared with an average rainfall of 32.78 inches for the succeeding five years. The average annual rainfall for a ten year period, 1896-1905 inclusive, stands at 33.23 inches. The average monthly precipitation for the first period reached the maximum point during the month of May, while the lowest rainfall occurred in January. In the second period, which includes the years 1901-1905, the month of May shows the maximum average precipitation, and the lowest point is reached during the month of January, thus there is a correspondence between the two periods. In general, our average monthly precipitation runs low for the months of November, December, January and February; then there is a gradual rise to the maximum point in the month of May and subsequently the average for the summer months shows a slight decrease from the maximum precipitation with a gradual decline for September and October. In the years 1906 and 1907 there was a slight deviation from these averages which were worked out for the preceding ten year period. In the former year the maximum precipitation occurred in September and the minimum in the month of February. It might be noted here that the rainfall for the summer months in 1906 was exceptionally heavy. In the latter year, 1907, our highest rainfall was reported for the month of June, and the lowest came in February. Very hot weather prevailed throughout the summer months.

FERTILITY REMOVED BY THE COTTON PLANT.

There are ten elements that are essential to the growth of a plant, namely: carbon, hydrogen, oxygen, phosphorus, potassium, calcium, sulfur, magnesium, and iron. Seven of these elements are present in sufficient quantities to meet the demands of the plant, and the grower can give his entire attention to the remaining

elements. These three, nitrogen, phosphorus, and potassium, are of paramount importance for the reason that one or more may be reduced to such an extent that the plant fails to obtain the required amount which is used in building the plant tissue. In other words, one or more elements may become exhausted. The soil can be considered as the farmers' stock in trade, hence each crop that is removed from the farm, reduces the supply of the essential elements. If a certain portion of a given crop is sold, we are interested in the composition of that part, in order that the depreciation in the fertility of the soil may be ascertained. The successful merchant takes an inventory of his goods once, or perchance twice, a year; while the farmer, who is generally admitted to be less exacting in his business methods, pays little attention to the condition or the amount of his soil supplies. This should not be true. Farming is a business, and the work of the farm must therefore be placed on a business basis. This embraces a study of the soil, and a knowledge of the crop. The following table gives the distribution of the essential elements in the cotton plant:

"Fertilizing constituents in a crop of cotton yielding 100 pounds of lint per acre."

Table I. a. (Pounds per acre).

	Nitrogen.	Phosphoric Acid.	Potash
Roots (83 pounds)	0.76	0.43	1.96
Stems (219 pounds)	3.20	1.29	3.09
Leaves (192 pounds)	6.16	2.28	3.46
Bolls (135 pounds)	3.43	1.30	2.44
Seed (218 pounds)	6 82	2.77	2.55
Lint (100 pounds)	.34	.10	.46
Total crop (847 pounds)	20.71	8.17	13.06

a. Office of Experiment Stations, Bulletin No, 33. (p. 84).

Reference will not be made to the first four items included in this table, inasmuch as the fertilizing elements found in the root, stems, leaves, and bolls are returned to the soil as soon as the cotton crop is harvested. With the exception of cases where it is expedient to burn the cotton stalks, they should be cut in short pieces with a stalk cutter and incorporated with soil. In sections where the cotton boll weevil has made its appearance, burning all refuse upon the field has been recommended for the purpose of destroying as many of these injurious insects as possible. It should be remembered that the process of burning opens an avenue for the escape of that important element, nitrogen, and organic matter is destroyed; hence, as a matter of fact the stores of a substance which aids materially in se-

curing a perfect physical structure in the soil are diminished. If we compare the composition of the seed with the chemical elements found in the lint, it will be seen that the latter contains an insignificant amount of the fertilizing constituents; thus, our inference that cotton is not an exhaustive crop is correct, provided the fiber alone becomes an article of commerce. If this statement holds true in farm practice, the seed should be fed to the live stock on the farm, and the well-preserved manure must find its way back to the field from which the original crop was taken. There is another fact which is pertinent to this subject, but it is not brought to our attention in the analytical work reported above. A fourth division of the cotton seed may be made, thus a second product, cotton oil, can be placed upon the market and a minimum quantity of the essential plant food elements will be extracted. Cotton oil, like the lint, contains a very small amount of nitrogen, phosphorus and potassium. If the seed is sold from the farm and is subjected to the manufacturing processes of the cotton oil mill, the cotton seed meal can still be utilized for feeding purposes, thereby giving the grower a chance to maintain the fertility of the soil.

Perhaps there are cases where the cotton grower finds it necessary to market the entire product, seed and lint, and as very little stock is kept upon the farm only a small amount of the cotton seed meal can be used in the feed lot. On these farms some method must needs be adopted in order to return the nitrogen, phosphorus and potassum, which have been removed in the crop. Nitrogen can be secured from the inexhaustible supplies in the atmosphere through the use of a leguminous crop, like the cowpea. A careful examination of the roots of this plant will reveal small tubercles or nodules. These nodules contain microscopic plants called bacteria, and these little bacteria collect free nitrogen from the soil air, thus this element is stored within the plant. Where the nitrogen is supplied in a commercial form, the cost will approximate fifteen to sixteen cents per pound, and as this element is readily soluble in some of these substances, it will be necessary to make allowance for a partial loss through leaching. If the cowpea plant is used, the cost of getting nitrogen into the soil is not great and in the second place an opportunity is afforded to increase the supply of organic matter. If the remaining elements are deficient and we wish to make some return, farmyard manure, or a fertilizer containing the desired element, should be applied.

COTTON IN ROTATION.

A few years ago two rotations were outlined, and a definite section of ground was set aside for a permanent study of the effect of

these treatments upon the soil. Cotton is grown in one of these rotations; and four one-half acre plats are used in this experiment. Two of these plats receive manure at varying intervals, while the two remaining plats receive no manure whatever. The manured plats were given an application of well rotted barnyard manure at the rate of eight tons per plat early in February in the year 1902; and since that time no manure or fertilizer whatever has been applied. The following five year rotation has been arranged for these plats: first year, castor beans; second year, Kafir corn; third year, cotton; fourth year, oats; fifth year, wheat and soy beans. In 1902 the plats were plowed to a depth of five or six inches early in March and the surface was disked and harrowed immediately. From this date to the time of planting a light mulch was maintained on the surface through the use of a smoothing harrow. The Texas Storm Proof variety of cotton was selected for this trial and the planting was done April 26. The rows were located forty inches apart. A light rainfall during the month of April necessitated rolling after the seed had been planted in order to insure rapid germination. Four weeks later the plants were thinned to a stand of one stalk every 16 inches in the row. Three spring and two summer cultivations were sufficient to keep the plants free from weeds and preserved a soil mulch for the retention of the capillary moisture.

Five years later, 1907, cotton was again grown on this series. The soil was plowed on the 16th of December to a depth of seven inches. As soon as the plats were turned, they were given a stroke with a smoothing harrow; this treatment was repeated on March 18, and again just prior to planting. Owing to the fact that the spring was cold and backward, it was not possible to plant the seed until the 18th of May. The plan indicated in the preceding paragraph was followed in planting the crop. Three cultivations were given during the growing season. It should be observed that very wet weather occurred in June and this was followed by an exceptionally dry summer, hence we have three causes for a low yield during the season. The yield from these plats for the two seasons, 1902 and 1907, are reported in the following table:

Table II. Yield of seed cotton per acre

	1902		1907	
	Manured	Unmanured	Manured	Unmanured
Early	605.5	411.0	229.0	266.0
Medium	250.5	295.5	416.5	357.0
Late	85.0	132.5	260.0	229.0
Total	941.0	839.0	905.5	852.0
Dif. in favor of Manure	102.0		53.5	

In this trial the pickings have been designated Early, Medium and Late. The climatic conditions for the two seasons have been given, but it should be noted that the crop was much earlier in 1902 than in 1907. In the first season, the early pickings include all the seed cotton which was obtained from the two treatments up to October 6; while in the second season the seed cotton obtained up to the 30th of September only is given. The medium pickings for the first year, 1902, were taken from the field between the dates October 6 to 27 and the remaining returns were harvested after that date. In the second case, 1907, the medium pickings include a record of the seed cotton which was picked from October 1 to October 21, and the late pickings were secured after the latter date. A study of this table shows that in 1902 the manured area gave a yield of 941 pounds of seed cotton per acre, while the unmanured soil gave a return of 839 pounds, thus leaving a difference of 102 pounds of seed cotton per acre in favor of the treated land. In the second season, 1907, the manured area gave a yield of 905.5 pounds of seed cotton per acre, while the untreated plat yielded 852 pounds, hence there is still a difference of 53.5 pounds of seed cotton in favor of the treated plot. It should be remembered that no manure was applied prior to the second planting, but the plots received one treatment in 1902, and since that date six crops have been taken from this section. Manuring influenced the maturity of the crop in 1902, but this difference cannot be noted with the early pickings in the latter season. In the former case the manured ground gave, up to October 6, 194.5 pounds of seed cotton more than the unmanured area. Approximately two-thirds of the cotton on the manured ground in 1902 was ready for picking early in October, but at this date the cotton on the other plat had opened only about one-half of its bolls.

Where manure is applied to land upon which a crop of cotton is to be planted, it is advisable to make the application quite early in the year. The field can then be plowed at an early date and the soil will have an opportunity to settle before the time of planting. This affords ample time for the manure to decompose, thus the plant food becomes available during the early stages of growth. If the manure is applied late in the season and the material is rather coarse, it will have a tendency to hold the soil in an open condition. The soil moisture escapes readily when the surface is rough and open, and in the second place the manure will remain dry in place of decomposing. Later in the season decomposition will take place, and the available plant food provided at this stage of the plant's life may produce an extra heavy growth of stalk, which is detrimental to the formation of fruit. It is not necessary to make heavy applications to the land, and then allow the fields to remain for long

periods without further treatment. It would be better to divide this amount and make a light application,—say four or five tons per acre,—every five years rather than attempt to incorporate ten or twelve tons per acre once in ten years. In making an application of manure to a given field, plant food is not only added to the soil but the supply of decaying organic matter (humus) is also increased. Soils in this section of the country are deficient in humus, hence some method should be adopted so that the supply of this valuable substance may be maintained. Humus improves the physical condition of the soil. Where fields are cropped continuously to cotton, the humus is soon exhausted and if a field is somewhat rolling, the soil will have a decided tendency to wash. A systematic plan of cropping will assist in preventing soil erosion.

A rotation has been defined as a plan in which a recurring series of different annual crops are grown upon a given section. Investigators have found that various crops not only require, but absorb different quantities of the inorganic constituents from the soil; hence if a given crop is grown continuously for several years the special elements required by that plant may become depleted. Where several crops are used in a rotation and farm manure is applied to fields regularly and good use is made of the cowpea or alfalfa, the stores of plant food remain in a more balanced condition and better crops are secured. The object, in a rotation of farm crops, is to leave the land unimpaired and if possible to improve the field for the plants that feed to a greater extent on other constituents. In arranging the series, therefore, each crop should be given such a place that it will be benefited by the one which preceded it. The composition of the soil or climate conditions may lead to a modification or re-arrangement of the system in order to adapt it to the locality in which one is working. The benefits to be derived from such a system are well known. The work of the farm may be carried on more economically where different crops are grown in rotation. Plants differ as to their composition, and in the amount of food they require, thus an alternation in the cropping may assist in making an economical use of the food supply. The roots of plants are valuable as tillers of the soil, and as species differ in the habit of their root development a rotation gives an opportunity to use a deep rooted plant like alfalfa. Furthermore, a rotation offers more convenient seasons for the eradication of weeds, and it enables us at the same time to place a check upon insect enemies and fungus diseases which become common under a continuous system of cropping.

COTTON CULTURE.

As a general rule the soil should be plowed at least three months before the time when the cotton seed is to be planted. Cotton re-

quires a firm, well-settled seedbed, and unless the plowing is done early, this condition cannot be secured. The depth to which the soil should be plowed will depend somewhat upon the previous treatment of the field. In cases where shallow plowing has been practiced, it is not advisable to make any radical change the first season, and in working down to a greater depth a small increase should be made each season. This year the soil is turned to a depth of four inches, another year one inch can be added to this furrow, and similar progression can be made until the necessary distance is reached. A material change in the depth to which the soil is turned would bring a large supply of inert material to the surface, and the supply of available plant food in the upper layer of soil would be limited. Shallow rooted crops, like the cereals, would scarcely make a maximum growth on the inert sub-soil. Cotton sends down a long tap root, and it would scarcely receive as severe a check as wheat or oats; however, the seedbed should be placed in an ideal condition for the more vigorous growing plants. As soon as the field is plowed, the surface should be harrowed down thoroughly. In some sections farmers make a practice of listing their cotton ground quite early in the spring, and about a month later the field is re-listed and planted. During wet seasons cotton which is planted in a listed row may be placed at a disadvantage on account of moisure. On sandy fields such a plan affords some protection where the soil has a tendency to blow. From a quarter to one-half bushel of seed appears to be the proper amount to use in planting.

Tillage, or cultivation, has a two-fold object; first, it breaks up the surface soil and in forming a mulch prevents the evaporation of moisture; and secondly, it keeps the land free from weeds. The latter plants are objectionable in that they consume large quantities of moisture and plant food, hence the supply for the useful plant becomes limited. Surface cultivation should be given as soon as the cotton is large enough to permit the operation. There are cases where the harrow or weeder could be used to good advantage before plants make their appearance. Heavy showers frequently occur immediately after planting and a thick crust forms upon the surface of the field. This crust may become firm enough to prevent the young cotton from reaching the surface. A stroke with a smoothing harrow will aid these plants in breaking through, and the light mulch formed will also tend to conserve moisture for future use. As soon as the plants are up nicely, the surface soil should be stirred thoroughly to a depth of one or one and one-half inches. A spring tooth cultivator or an implement that has five or more teeth arranged in each section will do more effective work than a machine which has but two or at most three shovels on each section. The large,

heavy shovels roll the earth to some extent and unless some care is exercised the young plants may be covered with the moving soil. Some cotton growers recommend the use of the cotton sweep for the first cultivation. It is true that this implement is very effective in cutting off and destroying weeds which come up in large numbers early in the season, but it does not pulverize the surface sufficiently to form a good dust mulch.

When the cotton plants commence to show the third leaf, the crop should be thinned to a proper stand. This work can be carried out best by the use of the hand hoe. Cotton chopping machines have been placed upon the market within recent years. New devices are being added from time to time, and we are assured that when the respective types have been perfected, the cotton grower will be able to thin a much larger area within a given time than by following the old method. At this station good results have been obtained on upland soil by thinning to a stand of one plant every fifteen inches in the row where the rows are forty-two inches apart. The proper distance in the row can be gauged approximately by the eye where the work is done by hand and the chopping out or "blocking" can be done quite rapidly. It is a good plan to leave vigorous plants, having only a single plant in a place. Better results will be obtained by thinning early than by allowing the full row to make a strong growth before the field is blocked. In the latter case the extra cotton plants may be considered as weeds for they take up moisture and plant food which should be kept in store for the plant which will produce the crop. Early thinning insures a stronger growth in the plants which are allowed to remain. Any weeds in the row can also be cleaned out at the time of "blocking," and if the work is done carefully it will probably not be necessary to use the hand hoe again during the growing season. If a few weeds appear and it is impossible to reach them with the cultivator, they should not be allowed to go to seed but should be cut with the hoe or pulled up by hand. One noxious weed may furnish enough seed to get the same crop well started over the entire farm.

The culture, subsequent to the "thinning out", should be frequent and thorough. One writer states that "once a week and once to the row with a good horse cultivator is an excellent rule." However, it may not be possible for the man who has a large acreage devoted to hoed crops to cultivate the cotton crop each week; at the same time, plans should be laid to make the cultivations as frequent as once in two weeks. This treatment should be given up to the time when the plants commence to bloom, or at least until the ground has become well shaded. A single horse cultivator can be used

after this period to stir the surface, but some care will be necessary in order to prevent the implement from knocking off the blossoms. These early blossoms produce the early crop of cotton. It should also be noted that excessive culture at this particular period will have a tendency to cause the plant to produce an abundant growth of stalk, or to use the cotton growers' phrase, "It will encourage weed development." It will also have a tendency to cause "shedding" or dropping of the fruit. This is not a desirable feature, especially where an early crop of cotton is the object sought.

VARIETY TESTS.

Throughout the past six years the Experiment Station has tested a few varieties of cotton each season. Some of these strains gave excellent returns, while other varieties produced rather poor yields. The question is sometimes asked, "What variety of cotton will give the best yield under Oklahoma conditions?" A definite answer cannot be given. In these trials only a few varieties have been compared; and, it may be stated that outside of this group, desirable varieties may be found here and there in different localities in the new state. An examination of these types will reveal many variations, and it is to these promising plants that the grower's attention should be directed. A limited study of even a few types has afforded many valuable suggestions. If definite selections were made from some of the lower yielding varieties in our list, it is possible that within two or three years the selected material would give better results than the varieties which occupy a prominent position in our comparative work. As a general rule, seed which is brought in from an outside source will not give as high a yield for one or two seasons as well selected home grown seed. It requires a few years at least to bring about an adaptation to our climatic conditions, and when the plant has adjusted itself to the new environment, better yields can be expected.

In 1902, nine varieties were compared on the trial plots in this section. The soil was plowed in December and January and the cotton was planted on a well prepared seedbed in rows forty-two inches apart on the 14th of May. The seed germinated moderately well, and when the plants had made a fairly vigorous growth they were thinned to a stand of one plant every sixteen inches in the row. The field was given five cultivations during the spring and summer, and the first picking was made on the 13th of October. In reporting the yields, three divisions were make. The first division included the October pickings, the second division contained a report of the November pickings, and the final column reports the total yield in pounds of seed cotton per acre.

Table III. Variety Cotton. 1902.

No.	Name	October Pickings	November Pickings	Total Per Acre.
1	Russell's Big Boll	165.8	308.9	474.7
2	Culpepper's Imp.	289.4	247.2	536.6
3	Peerless	261.2	348.3	609.5
4	Peterkin	87.1	247.2	334.3
5	Excelsior	165.8	252.8	418.6
6	Allen's New Hybred	95.5	168.6	264.1
7	Blue Ribbon	219.1	230.3	449 4
8	Russell's Big Boll	98.3	353.9	452.2
9	African Limbless	115.2	303.4	418.6
10	Culpepper's Imp.	182.6	286.5	469.1
11	African Limbless	185.4	331.4	516.8
12	Mixed Variety	210.7	297.7	508.4
The following strains were grown in duplicate; Plats 1&8; 2&10; 9&11.				
1 & 8	Russell's Big Boll	132.0	331.4	432.4
2 &10	Culpepper's Imp.	236.0	266.8	502.8
9 &11	African Limbless	150.3	317.4	467.7

In this trial, three varieties were grown in duplicate and the average yields for these plats are inserted in the above table. The Peerless variety gave the largest yield of seed cotton per acre. The Culpepper's Improved stands second with an average return of 502.8 pounds per acre; while African Limbless comes third with an average yield of 467.7 pounds per acre. There was a marked difference in regard to the earliness of some varieties in this trial. Culpepper's Improved and Peerless variety exhibit this characteristic perhaps more than the other varieties under trial. The seed was planted rather late in the season and as a matter of course the maturity of all varieties was influenced to some extent. A heavy May precipitation also retarded the growth of the crop perceptibly; thus two causes may be ascribed for a late harvest. If the maximum yields obtained on this series are compared with the returns which are reported for the rotation plats in 1902, it will be seen that the cotton on the unmanured ground gave much better results than the variety cotton. This yield was given as 839.0 pounds of seed cotton per acre. There are three factors which may have assisted in bringing this increase on the rotation plats. First the variety of cotton used on the latter section has shown greater productivity than other varieties which have been grown within recent years. In the second place the cotton on the rotation plots was planted two weeks earlier than the seed on the variety section, hence the date of seeding may have had a beneficial influence. Furthermore some advantage was probably

gained from the systematic plan of cropping which is followed on the rotation field.

VARIETY TEST, 1903.

The field which was set aside for this experiment was plowed the first of April. The soil was placed in good condition and was planted to cotton on the 28th of the same month. This cotton seed germinated poorly and it was necessary to replant as late as the 9th of June. The field was given a thorough cultivation prior to planting in order to secure a mellow seedbed. Although the cotton was planted exceptionally late, fair yields were obtained from several of the plots. Eight varieties were selected for this trial. The seed of the Texas Storm Proof variety was obtained from plantings on the Station farm, while the seed of the remaining varieties was introduced through the Bureau of Plant Industry, Washington, D. C. The Texas Storm Proof variety was grown on large plots in addition to the plot which was used in this test. The yields for these larger areas was given with the results for the variety tests in the following table:

Table IV. Variety Cotton, 1903.

No.	Name	October Pickings	November Pickings	Total Yield
1	Texas Storm Proof	396.3	404.2	800.5
2	Parker	215.4	284.5	499.9
3	King	313.8	351.0	664.8
4	Allen's Improved	16.0	140.9	156 9
5	Seabrook	Cotton	failed to	mature
6	Griffen	22.9	172.9	196 8
7	Jones' Improved	18.6	180.8	199.4
8	Excelsior	31.9	154.3	186.2
I	Texas Storm Proof	338.8	477.7	816.5
II	Texas Storm Proof	298.0	661.0	959.0

In consulting this table, we note that the Texas Storm Proof variety stands at the head of the list with a yield of 800.5 pounds of seed cotton per acre. King variety stood second with a yield of 664.8 pounds of seed cotton per acre, while the Parker variety came third with a yield of 499.9 pounds of seed cotton per acre. The Seabrook variety failed to mature cotton. On a mutiplying plot, the Texas Storm Proof variety gave a yield of 959 pounds of seed cotton per acre, and on another section, which was not quite as uniform as the first, the yield was 816.5 pounds per acre. The low yield noted in the case of several of these varieties was due in a measure to the fact that the cotton was planted very late in the season; and in the second place, this was the first season that these varieties had been grown in this section. Most of them were brought from the southeastern portion of the cotton belt.

VARIETY COTTON, 1904.

Nine varieties were selected for the comparative test in 1904. The field on which this trial was conducted was plowed to a depth of seven inches in December 1903. Dry weather prevailed throughout the winter and early spring months, hence it was impossible to do the planting until the 20th of May. The crop was given good cultivation throughout the growing season, and the first picking was made early in October. The Texas Storm Proof and Seabrook varieties were grown in duplicate in this test and the yields for the individual plots are given in the following table:

Table V. Variety Cotton, 1904.

No.	Name	October Pickings	November Pickings	Total Yield
1	Texas Storm Proof	1064.0	378.0	1442.0
2	Russell	413.0	315.0	728.0
3	Pride of Georgia	357.0	283.5	640.5
4	Griffen	231.0	98.0	329.0
5	Parker	472.5	259.0	731.5
6	Seabrook	----------	52.5	52.5
7	Seabrook	----------	49.0	49.0
8	Allen's Improved	238.0	164.5	402.5
9	Truitt	374.5	329.0	703.5
10	Texas Storm Proof	815.5	451.5	1267.0
11	Egyptian	----------	185.5	185.5
12	Texas Storm Proof	1335.0	359.0	1694.0

The home grown seed, Texas Storm Proof, gave better results in this experiment than seed which was brought in from outside sources. Our best yield this season was obtained on a multiplying plot. The Texas Storm Proof variety was used and the yield was at the rate of 1694 pounds of seed cotton per acre. The three best varieties in this comparative trial stood as follows: Texas Storm Proof, 1442 pounds seed cotton per acre; Parker, 731.5 pounds of seed cotton per acre; and Russell, 728 pounds per acre. The Texas Storm Proof variety matured earlier than the other varieties in this list. Parker variety gave good results for the first season. Seed of the imported varieties was obtained through the Bureau of Plant Industry, at Washington, D C.

The Texas Storm Proof variety has been grown on the Station farm since 1901; however a record of the source of this seed is not available. The plant may be classed as medium in size. It produces one main central stalk, and has several strong basal branches. The bolls are moderately large, ovate in shape, and are generally five-locked. In our field work the percentage of lint has ranged

from 29 to 32 per cent. Last season a special study was made of a large number of individual plants. The season was very unfavorable, thus it is safe to assume that these plants did not make a maximum record. The following table illustrates some of the variations which may be found within a given field:

Table VI. Texas Storm Proof. Individual Plant Yields.

No.	Seed Cotton Grams	Per cent Seed	Per cent Lint	Date	Open Bolls	Total No. Bolls
4	320.0	67.8	32.2	9-23	8	55
35	232.1	67.5	32 5	9-23	2	30
14–A	212.9	65.7	34.3	9-23	4	44
18	205.9	67.6	32.4	9-23	10	45
7	120.4	66.2	33 8	9-23	11	30
1	102.4	66.6	33.4	9-23	4	30
14–B	67.5	66 2	33.8	9-23	3	34
23	27.7	70.8	29.2	9-27	5	42

This crop was late in maturing, hence only a limited number of bolls had opened by the 23rd of September. A careful examination was made at this time, and the most desirable plants were located and marked. Later in the season each plant was picked separately, and the product was placed in a single sack and marked. Each lot of seed cotton was ginned with a hand power machine during the winter. The best plant in this selection produced 320 grams of cotton; and this material was picked from 55 bolls. The plant giving the lowest yield of seed cotton contained 42 bolls. It is evident from this study that the number of bolls cannot always be taken as an indication of high production. Earliness was shown to some extent by plants 7, 18, and 4. Plant No. 14-A ginned the maximum percentage of lint, while No. 23 gave the lowest amount.

Two years ago a variety of cotton known as Cook's Improved was used on our trial plats. This variety was originated and improved by Mr. J. R. Cook of Schley, Ga.; and as very favorable results were obtained the first season our supply of seed was increased and this strain was grown on a special plot in 1907. The stand was rather poor; however, it was possible to make some special selections in the autumn. In this case the plants were marked on the 13th of November, and all the open cotton was picked. A careful record was made for each selected plant. The following table will serve to bring out the most important features of this study:

Table VII. Cook's Improved Individual Plant yields.

No.	Seed Cotton grams	Date of Picking	Bolls Open	Total No. Bolls	Production on basis of 36 bolls. (Grams)
1	209.0	11-13	39	76	192.9
2	185.5	11-13	29	44	230.4
3	196 5	11 13	26	47	271.4
4	215.5	11-13	37	87	209.5
5	278.5	11-13	46	61	217.8
6	301.2	11-13	51	83	212 4
7	240.0	11-13	36	57	240.0
8	284.9	11-13	36	82	284.9

The first picking which was made on the date indicated was saved for breeding experiments next season, and the remaining portion of the crop was discarded. Plant No. 6 produced 301.2 grams of seed cotton and in point of earliness it may be considered the best individual. This plant also contained the maximum number of bolls, but this product when compared on another basis was not as satisfactory as the product from other plants. If the bolls on these plants were uniform in size and the later pickings could be compared with the first lots, then the productive power of the respective plants can be worked out from another standpoint. Thirty six bolls from plant No. 8 gave 284 9 grams of seed cotton, while the same number of bolls from plant No. 6 weighed 212.4 grams. From the standpoint of production for a given number of bolls, this would place plant No. 8 at the head of the list. The chief items to observe in selecting cotton will be taken up in detail.

SEED SELECTION.

When the harvest season arrives, plans should be made to carry out some systematic work in seed selection. Vilmorin has made the statement that selection is the surest and most powerful instrument that man possesses for the modification of living organisms. Possibly no other plant will respond more readily than the cotton plant where judicious selection is made a matter of careful study on the part of the cotton grower. Useful characters only should be considered. It would be preferable to single out one desirable characteristic and endeavor to establish or fix that particular quality in the plant, rather than attempt to develop three or four characteristics at the one time. In selecting plants from which to obtain seed, there are several important lines of work that can be taken into consideration. The practical farmer will look for a variety that will produce a maximum amount of seed cotton per acre, but productive capacity is not the only item which should be chosen. With many varieties an increased length of staple or greater uniformity of fiber would be highly desirable. Further-

more, the quality of the fiber could also come in for improvement. Other varieties again are backward in maturing and as earliness in this section is a desirable feature some attention could be directed to the selection of seed from plants which are much above the average in this respect. Soil and climate are factors that have to be considered when the selection of a variety for a given locality is made. Plants can be selected as well with reference to their disease resistant qualities, thus it becomes possible to raise good crops in sections where failure has resulted owing to the existence of some fungus disease. Again, careful observation will lead to the conclusion that there is a marked difference in varieties with regard to the manner in which the cotton is retained in the boll, hence there is room for improvement of the storm resistant qualities of most of the varieties which are grown in the state at the present.

In the average season harvesting commences from the 10th to the 20th of September, but as the plants reach their full development a few weeks later than this date the work of selection cannot be done until early in October. The field should be carefully inspected and a number of plants which show marked superiority can be labeled. Each plant should be assigned a definite number so that exact information may be obtained when the entire crop for the season has been picked. In separating the best plants from the inferior grades, there are three or four items which should be given some prominence in the comparisons that are made. It has already been intimated that productiveness is a prime requisite, hence a plant containing a large number of well formed, good sized bolls should be taken in preference to the plant which contains only a medium number of bolls. "Like begets like" is an old well-established law and it would be proper to expect seed from the prolific plant to produce plants with like characteristics. A vigorous, well shaped plant should always be selected, since a plant of this description will carry a larger number of bolls than a plant which lacks in this respect. The earliness of maturity can also be ascertained at this season of the year. It would be well to select more plants than will be used for the reason that some of the individuals may fail to come up to the required standard.

After plants are labeled and numbered, small sacks with corresponding numbers should be provided so that the product from each individual plant may be kept in a separate sack. The earliness of the various plants can be determined by weighing the respective pickings as they are taken during the fall. A few notes and measurements may be made during the fall, and these in turn can be used for reference in making further comparisons. This part, however, is not absolutely necessary, but the suggestion is made so that

any who wish may follow the work through minutely. When the entire crop has been picked, the product from each individual should be weighed accurately and recorded. A careful comparison of these weights will enable one to select the best individual plant, or the best six plants in the list. The cotton can then be ginned, but scrupulous care should be exercised to see that no mixing occurs. It is a very easy matter to get a few inferior seeds from some outside source mixed with the pure lots. Return the pure seed to the respective sacks, and make sure the proper notes and numbers are recorded on each, and store the same in a safe place for the winter. In the spring a special piece of ground, and it may be added here that the soil should be representative of that portion of the farm upon which the general crop is raised, should be prepared for the seed patch. The selected seed from the best plants is planted on this ground, and the crop is given good attention during the spring and early summer. First-class plants are again marked and labeled in the fall and the pickings saved. At times it may be necessary to reject the progeny of a selected plant, thus a larger number of individuals will offer greater opportunity for work the succeeding year. The seed from the individual plants can be planted in single or separate rows; and the results for the season may be compared. Select one dozen plants in the seed plat from the various rows and determine the total yield made by each plant. Seed from the best plants can be used in planting the special plat the second season. Extra seed from the special plat the first year can be used for planting a larger area, which is known as a multiplying plat, while seed from the multiplying plat the second year can be saved and used on the commercial field the third year. The same definite plan may be carried out on the special plat each year, and an increase of seed for the improved strain can be obtained through the multiplying plat.

The average cotton grower may not care to carry out such a detailed line of work, in fact he may not have the spare hours to devote to a careful study of such a method, and yet he desires to bring about improvement in the variety which is grown upon his farm. A simple method can be suggested for adoption under such circumstances. When the picking season arrives, two or three good hands can go over the field and mark the most promising plants that can be found. Select vigorous, productive plants. As soon as the second picking is ready, the marked plants should be visited and all the mature cotton removed. This cotton is placed in special sacks for planting, and the seed obtained therefrom is used for planting the coming year. A few hours spent in marking and picking the cotton from the best plants in the field will in the course of a few years re-

sult in a decided improvement in the yields which are obtained. Every cotton grower should make this work a part of his business.

CONCLUSIONS:

1. The cotton crop takes an important place on the farms of Oklahoma. With an enormous increase in acreage, and the cultivation of extensive areas our attention may be diverted from proper channels; thus the grower may fail to appreciate some of the fundamental principles which are involved in the improvement of this fiber crop.
2. Cotton is not an exhaustive crop provided the seed is retained on the farm. Where the entire crop is marketed, and a continuous system of cropping is practiced, soil exhaustion will soon be in evidence.
3. Farm manure is a by-product of the Oklahoma farm. This material contains plant food and with the best possible care it should be returned to the land. In applying farm manure, plant food is not only added to the soil, but the supply of vegetable matter is also replenished. Humus impoves the physical condition of the soil.
4. Best results can be secured when cotton is grown in rotation with other crops. Such a plan facilitates the destruction of insect pests, and enables the grower to eradicate noxious weeds. Soil erosion may also be prevented in a measure when a good rotation is followed.
5. It cannot be stated that there is a variety which is better adapted for all parts of the new state than other well known varieties. Every cotton field contains individual plants which have desirable characteristics. Such plants should be isolated, and the product of these selected plants can be used to increase the productiveness of our fields.
6. The following characteristics should be observed in selecting cotton: a. Productiveness; b. Quality of lint; c. Length of fiber; d. Earliness; e. Storm resistance.

THE COTTON BOLLWORM.

The cotton bollworm, kncwn also as the corn ear worm, is the insect that does the greatest amount of damage to the cotton crop of Oklahoma at the present time. The damage done to corn and cotton by this insect makes the losses in this state enormous, aggregating millions of dollars. The insect prefers corn to cotton, but when the corn becomes too hard for its operation it turns its attention to the latter plant. The cotton is in a receptive stage at this time, since the blossoms offer food for the moths and the bolls and squares serve as excellent structures for the development of the little worms.

The farm value of the corn crop in Oklahoma for the year 1907 was $49,837,000. The cotton boll-worm damaged this crop at least 4 per cent, making a total loss to the corn growers of $1,993,480. The estimated value of the 1907 cotton crop in Oklahoma was $45,-950,000. The cotton bollworm damaged this crop at least 2 per cent, making a total loss to the cotton growers of Oklahoma of $919,-000. The grand sum therefore of $2,912,480. was the amount lost by the Oklahoma farmers on account of this one insect.

DESCRIPTION OF THE INSECT.

This insect, like all other moths, has four periods of development which constitute the life cycle. The adult form is the miller or moth; the other stages of development are the egg, the worm and the pupal or resting stage. The adult moth is very variable in color and markings, ranging from almost white to a dull greenish color. The length of the body is about three-fourths of an inch, while the distance across the wings when spread is about one and three-fourths inches. The moths feed upon the nectar of the cotton flowers, and the syrupy exudate upon the stems and leaves of the cowpea. The moths fly largely in the evening, depositing eggs at random upon the surface of the plants upon which they are feeding. The number of eggs deposited by a single moth is about 2000. The length of life of the moth is from five to twenty-three days, depending upon the amount of food supply.

THE EGG.

The egg of the bollworm moth may be deposited upon several of its favorite plant foods, but when corn is present a large proportion of them will be deposited upon this plant. The moths deposit eggs at random and may place them upon neighboring weeds. The length of time required for the eggs to hatch is about one week.

THE LARVA OR WORM.

The larval stage of this insect is the one in which the damage to the corn and other crops is done. The little worms hatching from the eggs immediately seek their natural food supply, but in doing so they may feed for a limited time upon the surface of the leaves of

the plants upon which they were hatched. They are too small to travel from plant to plant, and should they be unable to find their desired food they may perish, The number of plants that the insect can live upon during this stage is so great, however, that there is little chance of many individuals being destroyed in this way. The fact that the tiny worm feeds for a short time upon the surface of the leaves has suggested the possibility of holding it in check by the use of Paris green. The use of Paris green on a limited area of cotton has given quite uniform and valuable results, but the methods cannot be recommended in general for the destruction of this pest in large fields. The length of time that it requires for the little worm to develop into the full grown worm, measuring from 1-¼ to 1-½ inches in length, depends upon the temperature and the abundance of food supply. The average time required is sixteen days. The color of the larva is not uniform in the different individuals. Some of them may be pale green, with a few marks, while others may be almost black; pink and brown individuals are frequently found. The insect, while in the larval stage, is canabalistic. Should two or more reach the same ear of corn or the same boll and come together, the stronger will destroy and devour the weaker one. This accounts for the fact that we seldom find more than one fully developed worm in each ear, although hundreds of eggs have hatched in the neighborhood of that ear.

THE PUPAL OR RESTING STAGE.

The pupa is a dark brown case about an inch long, pointed at one end and showing the segments of the body. This is the stage in which the transformation from the worm to the moth takes place. When the larva has completed its growth, it leaves the plant upon which it has been feeding, and crawls down to the ground, where it passes the pupal stage. The insect seldom travels farther than a foot or two from the plant upon which it has grown before it finds a suitable spot to enter the soil. The soil is penetrated to a depth of about two to six inches, and the burrow, up to within a fraction of an inch from the surface, is lined with silky material, thus forming an easy passage way for the egress of the moth which will later appear and use this tunnel to reach the outside world. The length of time that the insect remains in this pupal stage depends upon the season. During the summer it remains only two to three weeks, while in the fall and winter it may extend over several months. The insect passes the winter in this state and this latter fact explains the advisability of fall and winter plowing to break up and expose these pupal cases so that they will be destroyed by the elements or by birds. The breaking up of the chamber or burrow, even though the case is not brought to the surface, will so cover the structure

that the moth, when it appears, will be unable to escape. Cultivation and working of the soil continually through the summer breaks up and destroys many of these cases and thus lessens the number of insects which appear later upon the crop.

MEANS OF CONTROL.

While this insect is able to live upon a great variety of different kinds of plants, 70 or more in all, it has its preferences. Its favorite food is the corn plant, and in the north this insect becomes one of the most serious destroyers of that crop. Its second choice of food plants is cotton, and in the south this crop is seriously damaged by this insect. This insect should not be confused with the Mexican cotton boll weevil, an entirely different pest, but should be identified with the ear worm, corn worm, tomato worm, and bud worm, since this insect bears these different names, depending upon the crop attacked by it.

This short account of the life habits of this insect suggests a few methods that might be employed to lessen the losses occasioned annually by this pest. The methods of first importance are those known as agricultural or cultural methods. Such methods as fall and winter plowing; thorough cultivation during the growing season; the growing of more resistant and more early maturing varieties of crops; fertilizing the soil to produce more vigorous growth; the use of trap crops, are methods that fall under this heading. The methods of second importance are those known as mechanical or poisoning operations. Under this head we have such operations as, spraying with Paris green, the use of trap lights, etc.

In a series of experiments with several of these different methods, it has been found that the agricultural practices can be depended upon to materially lessen the losses from this pest. During the last season several experiments were conducted, making use of fall and winter plowing, clean and vigorous cultivation, and trap lights. These experiments are not completed at the present time, for it is desired that they should cover a period of several years in order to determine the full benefit that can be derived from a general practice of these methods. These three methods are to be carried over a period of five years. The results of this year's work certainly indicate the value of the methods that are being employed,

SUMMARY:

1. The cotton ground should be plowed during the fall and winter.
2. Plant early and rapidly maturing varieties of cotton.
3. Plant five or six rows of June corn in the cotton, placing the corn about every 200 rows. Plant the corn about June 1.
4. Cultivate corn thoroughly and thus lessen the number of worms which may at a later date attack the cotton.