

EXPERIMENTS WITH CORN.

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Sixteen acres of corn were grown on the grounds of the Iowa Experiment Station in 1889. The principal part of it was produced from the best ears of our last year's crop of Leaming corn, and the remainder consisted of Arleus and early Mastodon corn. It was grown on a black heavy soil, which was too wet formerly in wet seasons, to produce paying crops of anything, except grass; but last year it was tile-drained thoroughly.

The greater part of the field had been used for many years as a pasture and the remainder, (perhaps five acres) was a part of an old field which had been used for different kinds of crops. It was well plowed early in September, 1888. Last spring, we ran over it twice with a disc harrow and once with a reversible harrow and then plowed it about eight inches deep. Then we ran over it again with a disc harrow and a reversible harrow and also with a heavy farm roller. It was planted May 2d and 3d, with a two horse planter in rows three feet and eight inches apart. From two to three grains were planted in each of the hills, which were thirty inches apart in the rows; but the entire field was thinned afterwards to two stalks in each hill. The field was harrowed twice with a Thomas smoothing harrow after the corn came up; when it was divided into four lots, each of which was cultivated four times afterwards and hoed once. The south lot was cultivated each time with the Tower cultivator. The lot next to it was cultivated each time with the Eagle-Claw cultivator. The next or third lot, was cultivated with the riding Pearl cultivator, and the remainder of the field each time with the Albion Spring Tooth cultivator. The work of the Tower cultivator was excellent where oat stubble had been plowed under; but where old weeds or corn stalks were near the surface of the ground, it did not work well. The work of the Eagle-Claw cultivator was better than could be done by the walking or riding plows which are used in every neighborhood; because it pulverizes the surface of the ground better and leaves it level. But the Albion

Spring Tooth cultivator excels all other kinds which we have used, on all kinds of ground and in every respect. When our crop of corn was husked and measured during the latter part of October, the yield of the entire field proved to be eighty bushels per acre of sound shelled corn. I find from the reports of the Secretary of the Iowa Board of Agriculture, that the average yield of corn in Iowa for the years 1883-8 inclusive, was 31 and $31\frac{2}{3}$ bushels per acre. The highest average yield per acre for a single year, was considered remarkable, being $41\frac{1}{4}$ bushels. When we compare such crops with our crop, we can not help asking, why are there such differences?

As I have never succeeded in growing good crops of corn, except when they were surrounded by very favorable conditions and when good seeds had been used—I have good reasons for answering, that they were caused by differences between the methods which were adopted for preparing the ground for corn; or difference between methods of culture, or differences between the characteristics of the kinds of corn—which were used for seed. But, as this general answer may not be sufficiently explicit, I will endeavor to make it clearer. The principal part of the food materials which are necessary to produce large and healthy plants, are obtained from the soil. They consist of nitrogen, potash, phosphoric acid, lime, sulphur, soda, magnesia, chlorine and silica. They are never used by plants when dry or in a liquid condition, but only in the form of vapor. Much of each of these substances is present in new soils in a soluble condition, but in old fields which have been cropped for many years, they are found generally in an insoluble condition. They are rendered soluble in water only to a limited extent; but they are dissolved readily by carbonic acid and other gases which exist in the atmosphere. Many of our fields appear to be very poor, because we have never plowed them more than six inches deep, and many crops of corn, wheat and oats have absorbed the greater part of the soluble plant food which the surface soil contained. In such instances, much deeper plowing or sub-soiling would enable us to grow larger crops, as the roots of corn would be able to reach new stores of soluble plant food. To produce profitable crops, the mechanical condition of the soil must be provided, which is necessary to furnish constant supplies of moisture to the depth of two or three feet. On wet soils, tile drainage is absolutely necessary; while on dry rolling ground, sub-soiling once every fourth or fifth year would be sufficient. Moisture moves in

all directions through the soil, but especially upwards from the sub-soil by capillary attraction, as oil moves upwards in a lamp wick. Very compact soils are benefitted but little by capillary attraction; because the particles of matter of which they consist adhere so closely together, that particles of moisture can climb only very slowly between them. Deep cultivation in very dry weather also destroys the power of capillarity, as it leaves the particles of soil too far apart to support particles of moisture which would ascend between them, if they were closer together. New fields or clover sod are more productive than old fields, not only because they contain more soluble plant food, but because they contain more vegetable matter, which renders the soil moist by improving its mechanical condition and increasing the power of capillarity. Soils become dry and warm much earlier in the spring and after heavy rains, when they are in good mechanical condition, than when they are very compact.

It is generally admitted that cultivation improves crops of corn, potatoes, etc., but why it is necessary? and how it should be done? are questions upon which men differ.

No one will deny that it is necessary to kill the weeds; but beyond this point, the effects of cultivation are not clear to many men, and the result is, that it proves more injurious frequently than beneficial. Many deep and shallow tillage experiments have convinced me, that (aside from the killing of weeds,) we should have but two objects in view, viz:—the retention of moisture in the soil and the attraction of more to it from the atmosphere.

In 1887, I lost 100,000 apple grafts, which I planted on spring plowing, that was nearly as dry as dust for several weeks; while more than 100,000 grafts which I planted at the same time on moist fall-plowing, started well and grew well, on account of my giving them frequent shallow culture. At other times during severe drouths, I have injured crops by deep tillage and saved others by frequent shallow culture. What corn and other plants which require summer cultivation need most, is a light mulch which will shade the ground, without excluding the atmosphere from it. Such a mulch may consist of straw, leaves, old boards or an inch or two of loose soil. The latter is not only a good mulch, but it is the cheapest; as it can be applied and renewed as often as necessary by frequent, shallow culture. In very dry weather, deep culture not only breaks more or less of the corn roots, but it leaves a deep mass of loose soil near the

unbroken roots, which becomes so dry and hot frequently, that it is very unfavorable to plant growth. But objections are offered against shallow culture very often ; because weeds can be destroyed better by deep culture when the ground is wet.

To such objections, I have but one answer to give, and that is, that neither deep nor shallow plowing in mud, has ever proved profitable crops. If we can not afford to drain wet fields, it will pay best to keep them in grass for hay or pasture. When we are planning for future crops on the different parts of our farms, we should not forget that the different species of plants require the various kinds of plant food in different proportions, or that they have the wonderful power to select and absorb such mineral substances as are adapted to their wants. "Thus, when wheat and peas are sown together, the former will select silica in preference to lime and the latter will select lime in preference to silica. Buckwheat will take chiefly magnesia ; while beans will select potash." A crop which requires much potash, should be followed by another which would select other mineral substances, to allow time for the accumulation of soluble potash in the soil. No money can be made by growing corn which will not yield more than forty bushels per acre ; but we could double the Iowa average yield for the last decade, by adopting a proper rotation of crops ; by providing more soluble plant food in our fields ; by better preparation of the ground for corn, and by more frequent shallow culture.

Clover grows well in Iowa, and by sowing it plentifully and by using our manure more carefully, we could secure an abundance of the soluble plant food in a short time, which is necessary to make farming profitable. But to grow eighty bushels of corn per acre, there must be no stops for even a day or two on account of wet soils or drouth, but constant growth from the time that the seeds germinate until the corn is ripe.

In our Experiment Station Bulletin number 2, are explanations of many experiments which we made last year on different kinds of corn, under the heading.—Corn Tassels, Silks and Blades. This year we repeated a part of them, besides trying many others. Last year, I showed that the Sanford and different kinds of sweet corn produce two or more good ears on each stalk ; because the long blades on the points of their husks enable them to assimilate much more plant food, than is assimilated by varieties which do not have such

blades. I will repeat here the results of last years experiments, which I verified this year by similar experiments, viz:

1. The tassels and the silks of primary ears appear generally about the same time.

2. The upper central spikes of the tassels, shed their pollen usually about twenty-four hours before the pollen of their lateral spikes is ready to fall.

3. The first silks which protrude through the husks, are from the lower ends of the ears and the silks above them follow gradually until all are exposed.

4. Usually twenty-four hours elapse before silks are in a receptive condition, after their first appearance.

5. Generally, the silks at the tops of ears are from two to five days later in appearing through the husks than the lowest; but frequently the upper silks are not more than twenty-four hours later in appearing than the lowest and sometimes they are ten days later.

6. When the lowest silks appear four or five days before those at the upper ends of ears, the lower grains of corn will be old enough and sufficiently strong to rot the younger and weaker upper grains, and cause them to die from starvation.

Therefore, when there are such differences, the ears will not be properly filled at their upper ends; but when the difference amounts to only twenty-four hours or less, the ears will be as fully developed at their upper ends as at their lower ones.

7. When well grown, the best corn for Iowa will not exceed $9\frac{1}{2}$ feet in height, its ears will be $3\frac{1}{2}$ feet from the ground, and each of its stalks will have thirteen blades.

It is not safe to plant corn in Northern Iowa which will not ripen by the tenth of September, and for Central Iowa it should not be more than five days later.

As no other crop is grown on so large a scale in Iowa as corn, I determined last year to make the improvement of it one of our specialties. Having procured the catalogues of most of the seedsmen in the American corn belt last winter, I examined them carefully and ordered many kinds which were recommended highly. At planting time, I had a much finer collection of varieties than I had seen at any of our state fairs; but I discarded many of them; because they lacked one or more of the characteristics of my ideal standard of excellence. The best, (our model variety) would ripen at the proper time and yield more corn than any other kind. It would have well developed ears, of good length and many rows of deep grains. The varieties of dent corn

which appeared to have the most desirable characteristics, were planted on a rich, well prepared plat of ground by themselves, for the purpose of reducing the labor as much as possible which I intended to expend in cross-fertilizing them. They consisted of the following kinds, viz: our own best Leaming corn, Nebraska Leaming, Edmundson, Mammoth Cuban corn, Arleus, Early California, Shoe Peg, Profit corn, Early Mastodon, Big Buckeye, Miller corn, McLain corn, Riley's Yellow Dent, King of the Earlies and Pride of Nebraska. We also planted two flint kinds, the Sanford and a new variety directly from the Philippine Islands, on the west side of the plat. The Nebraska Leaming, Early California, Big Buckeye, Miller corn and McLain corn, were too tall and late for Central Iowa and did not ear well. The Pride of Nebraska produced long ears, which had only from twelve to fourteen rows of short grains (See A and 4 on Plate II). The upper ends of the Arleus ears were very defective. Mammoth Cuban corn is an inferior strain of Leaming corn. The ears of Profit corn vary too much in size and numbers of rows of grains. The Shoe Peg has only from fourteen to sixteen rows of grains and is not sufficiently productive. The Early Mastodon is far from being a distinct variety, (as some of its ears were early and others late;) but it has characteristics with which I am well pleased, viz: long grains, and many ears have from twenty-six to thirty-two rows of grains. I have saved a considerable number of ripe and well developed ears of this variety having from thirty to thirty-two rows of grains, which I will plant next spring for the purpose of having its pollen to use on the silks of our best Leaming and Edmundson corn. The two last named varieties are the most valuable of all of the kinds which we have tested for Iowa; but as the Edmundson is earlier than the Leaming, I would prefer it for the Northern third of the state. The King of the Earlies, which I procured from seedman Bouk of Nebraska, is also a valuable deep grained variety having from twelve to sixteen rows, which ripened here this season in ninety days from the date of planting. (See D on Plate II).

Last spring I planted twelve kinds of sweet corn also on a separate plat of ground. I had Mammoth Sugar corn from Massachusetts, Pennsylvania Ohio, Missouri and from Livingston, the seedsman of Des Moines. There were remarkable differences between the corn received from the different sources under the same name, viz: in time of ripening, height, size of ears, number of rows of grains and in qual-

ity. The Massachusetts corn was earliest and least, and the Livingston was late, but remarkably large and best. The Livingston corn had also much longer blades on the points of its husks than the Mammoth Sugar corn received from other sources. The stalks and blades of the new Gold Coin sweet corn, have the characteristics of the yellow dent corn. It is a cross between the latter and a sweet variety. Its table qualities are good, but it is very late and non-productive. We will discard the Pride of America, the Cory and New Cory sweet corn, as nearly all of their ears have been rendered unfit for table use for two years by Boll worms. The spaces between their ears and husks are sufficiently large, to permit the worms to crawl all over them. Our other varieties of sweet corn were not injured by Boll worms, as their husks were properly fitted to their ears. The Chicago Market was our best early variety. Last July and August, I cross fertilized and self fertilized more than 500 ears of corn of different varieties. The work was performed carefully and all of the ears were covered at the proper times with very thin paper sacks; but when they were ripe, I did not save more than one third of them for seed, as I found that I had made mistakes in using pollen of the inferior Arleus and McLain corn freely. Hereafter, I will not be obliged to repeat such mistakes, as I have a sufficient number of such varieties now, as are necessary to produce kinds which will suit me. But, to make progress rapidly, it is necessary that we should have an ideal type of stalk and ear, and that no mistakes should be made in adopting our standards of excellence. I have determined upon such types, and I will describe their characteristics.

The variety which we want for Central Iowa, must complete a season's growth in 115 days of ordinary summer weather.

It should be $9\frac{1}{2}$ feet high when well grown; its ears should be $3\frac{1}{2}$ feet from the ground; it should have thirteen blades on each stalk and well developed blades on the points of its husks; it should have long ears, having thirty rows of deep grains on each ear, and the ears should be equally large at both ends and show no missing grains. I consider the second, third and fourth characteristics which I have named necessary; because I have found, (after many careful examinations,) that the largest and best ears are found generally on stalks which have such characteristics. Why are not taller stalks, just as good or better? Because, when planted at the usual distances apart, their lower blades are shaded too much.

No plant food is ever assimilated by blades of corn or leaves of other plants, except when under the direct rays of the sun. In fields of tall corn, the lower blades generally die prematurely and the weeds become stunted and sickly, because they are not sufficiently exposed to the sun. When corn has acquired the characteristics of growing tall in a wet or very cloudy climate; its blades will be thin and inclined to be sickly during spells of drouth, which would not injure the Sanford or Leaming corn. I would have blades on the points of the husks; because the productiveness of the Sanford and many kinds of sweet corn which have such blades, proves that they assimilate more plant food frequently, than the blades which are attached directly to the stalks. A large ear of Leaming corn is represented at figure 3 on Plate III, and a great majority of the ears of the different kinds of corn are shaped like it. But it is very unlike my ideal ear, as much less corn is on its upper end than on its lower end.

The large ear of Leaming corn shown at figure 1 on Plate III is a much better ear; because it is equally well developed at both ends. But it is defective, as it has only twenty-two rows of grains, when it should have thirty rows like the section of Leaming corn shown at B, and the section of Early Mastodon corn shown at C on the same plate. Objections are sometimes made against such large cobs as are shown at B and C on plate III; but I want thirty rows of large grains on each ear and I can't get them on a small cob. Extreme size of cob is not a fault, when it is produced by an early variety. The ear which is shown at B on Plate II and many others like it, which I have saved for seed, ripened and dried out earlier than four-fifths of the corn which is grown in Iowa. To produce ears, shaped like the one which is shown at figure 1 on Plate III, I would select cocks-comb pointed ears, or ears like the Leaming ear at figure 2 on the same plate, and plant them where they would be fertilized by their own pollen. By continuing to select such ears for seed from the same stock, but little time would be necessary to produce the desired result. It is but seldom that ears of corn do not have the points of their cobs exposed, like the ear at figure 2 on Plate II. This is a serious defect, but by continued selections of ears for seed, which expose all of their silks within twenty-fours, hours, (or ears that are well filled at their upper ends) it would not be difficult to breed a strain of corn, which would be fully developed to the extreme ends of the cobs. I will offer the following examples, to show that the butt and

top silks of ears are exposed at different times, and that such differences amount to several days frequently.

The Edmundson ears 1, 2 and 3 on Plate II, were covered with paper sacks at the same time, and when only a few of their silks were visible. One day afterwards, number 1 was pollenized with Edmundson pollen and covered again with a paper sack. Number 2 and 3 were treated like number 1, except that number 2 was pollenized two days after being covered, and number 3 was pollenized three days after being covered. It will not be difficult to determine the number of silks which were in a receptive condition when number 1 and 2 were pollenized; or to see that all the silks of number 3 were in a receptive condition when it was pollenized. Numbers 5 and 6 on Plate III represents ears of Sanford corn. It is a light cream colored flint variety. The ear at figure 5 was covered with a paper sack, when only a few of its silks were visible. One day later, it was uncovered and pollen of the yellow dent Leaming corn was applied to its silks when the paper sack was replaced. Twenty-four hours afterwards, it was uncovered again and pollen of the Livingston Mammoth Sugar corn used on its silks, when it was covered again. When this ear was ripe and I husked it, I found that fourteen grains on the upper end of each row, were apparently pure Sanford corn, and that nearly all of the grains belowthem, were of a bright yellow color. The Livingston Mammoth Sugar ear at figure 4 on Plate II, was properly covered when its silks began to appear. Five days later, it was pollenized with its own pollen, when the paper sack was replaced. In this instance we can see that all of the silks were in a receptive condition when the pollen was applied. On July 25th, I covered ten ears of Arleus corn when their silks were just beginning to appear, and the next day I covered ten others of the same variety.

On August 16th, I removed the sacks from the twenty Arleus ears and applied pollen of the Livingston Mammoth Sugar corn plentifully to their silks when they were properly covered again with sacks.

When I husked the twenty ears in October, I found that I had been one day too late in pollenizing the ten ears which were covered on July 25th, as all of them were like the ear at figure 5 on Plate III. But I was just in time to catch a few silks in a receptive condition on each of the ten ears that were covered on July 26th, as all of them were like the ears at figures 1, 2, 3 and 4 on Plate III. Here we have a lesson that is worth studying. From the results of many experi-

ments, I know that the lower silks on the ten Arleus ears which I covered on July 26th, were in a receptive condition on July 27th, and the results of this experiment show, that their upper silks were fertilized twenty days later. I have had but little trouble in crossing the different varieties of corn on each other; but in a few instances the pollen of one kind was not received kindly by another, thus: I pollenized Edmundson silks with pollen of McLain corn, and the result can be seen at figure 6 on Plate III. I have also tried to cross the Early Mastodon on the Edmundson, and the result can be seen at figure 7 on Plate III. The three ears represented on Plate IV were covered with paper sacks for fourteen days. When the sacks were removed from them I found that many of their silks had protruded beyond the husks from ten to fifteen inches. I also found that the lowest silks were dead; that at the middle of the ears, they were in a receptive condition; while the very short silks at the points of the ears, appeared to be too tender or immature to be in a receptive condition.

On the south side of the sweet corn plat, I had Livingston's Mammoth Sugar, Gold Coin sweet corn, the Sanford, (flint) and yellow dent corn planted together. When I husked the corn where the above named varieties were planted, the immediate effects of cross-fertilization were very evident; but especially on the Mammoth Sugar ears, several of which contained many white and yellow flint grains, and more or less Gold Coin and yellow dent grains. We will continue our experiments next year, and will endeavor to make practical use of the information which we gathered last year and this year.

We have not saved any seed corn, except for our own use.







