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INDIAN CORN
Its Production and Improvement

—BY—

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INDIAN CORN:
Its Production and Improvement.

I. Introduction.

The general purpose that the writer has in view in the preparation of this bulletin is to promote the interest that is awaking in Idaho in America's greatest cereal,- Maize or Indian corn. There is a greater interest being taken in this crop in this state than is generally supposed. During the three years that the writer has raised corn, thought corn, and talked corn in Idaho, he has been conscious of a deep undercurrent of interest throughout the State from the Canadian border to the mountain valleys of Cassia. This is what might be expected of a population made up so largely of those who have come from the several states of the Mississippi valley. Here and there throughout the broad expanse of mountains, forests, plains, and valleys of Idaho little dots of waving green could have been seen years ago where some courageous soul, homesick for the miniature dark-green forest of the "Corn Belt," and regardless of the pitying smiles of those who "knew", ventured to plant a few kernels of the golden or silver ears he had carried across the mountains. By careful selection of the few ears that escaped the early frosts, a measure of success had come, and corn growing in Idaho was born.

The writer had no part in these first attempts at growing what bids fair to become one of our principal crops, for in some localities success has come only after many years of patient and persistent effort. His mission has been to encourage the enlargement of the present small areas of corn and the establishment of many new ones, and to aid in the general improvement of the crop throughout the State.

The problem of making corn a profitable crop throughout the State of Idaho is one of many phases. There is probably no other state in the Union where the conditions of environment influencing plant growth are so varied as in Idaho.

Extending from the forty-second to the forty-ninth parallels of latitude, and varying in elevation from 600 to 13000 feet above sea level, there must of necessity be a considerable range in climatic conditions; and because of the wide variation in the various types of soils, there is a great difference in the store of available plant food present and in the relation of soil to moisture. Then, when we reflect that the crop will be produced where there is an abundance of moisture available, either from the natural rainfall or from the irrigation ditch, and also where the system of "dry-land farming" must be practiced, it is evident that the conditions to be met are many and diverse.

In no part of the State is corn more needed, nor does it promise better results, than in the wheat district, where the practice of bare fallowing is common. That the bare fallow is not essential to the production of a good wheat crop has been abundantly proved. A field on the Experiment Station farm averaged over fifty-four bushels of wheat per acre after corn. The previous year a heavy crop of corn had been grown for silage. The soil is the same type as the thousands of acres in this section that are farmed under the bare fallow system. When the fallow is not cultivated, as is often the case, weeds appear and sap from the soil plant food and moisture, and mature a crop of seeds to further befoul the land; when it is cultivated, although the soil is in fine condition for the succeeding wheat crop, a very little extra labor would result in a crop of corn, which would be almost clear gain. If the corn is cut for silage, or cut and shocked, it will hinder seeding very little, a disk harrow putting the soil in fine condition. Where there is not sufficient rainfall to produce a profitable crop every year, and "dry farming" must be practiced, the soil must be fallowed when the moisture in the soil becomes insufficient for the needs of the crop, but in the wheat section such a condition would be the exception.

It is not contended that wheat and corn can be grown constantly, and the land not deteriorate, but we do say that with a *proper rotation* the soil can be cropped every year with less deterioration than when the rotation is wheat and bare fallow, especially if the latter is not cultivated.

To meet the many conditions present with us, we must either have a variety with almost limitless powers of adaptation, or a number of varieties or strains of varieties, each of which is adapted to the conditions of a certain locality. The former is impossible with the corn plant, as its powers of immediate adaptation are limited; but the ability to form new varieties or strains adapted to a wide range of conditions is possessed by the corn plant to a remarkable degree. It is this latter fact that makes it possible for us to say that corn can be made a profitable crop in most parts of Idaho. In some localities the end may be attained in a short time, but in others it will take years of careful and patient endeavor to achieve success. This statement is not based on theory, but upon what has been accomplished. Many who read this know that not many years ago it was thought impossible to raise corn in Minnesota or the Dakotas, while now it is becoming an important crop in many parts of those states. There are those that can testify that this very thing has been done in many localities in Idaho, as was mentioned above. As a matter of fact, corn was originally a tropical plant, which, as the centuries rolled by, gradually varied and marched onward until it reached the fields of southern Canada. It is not a mere experiment we wish to urge upon the farmers of Idaho. It is a definite practice, which, if faithfully carried out, cannot fail to produce satisfactory results. With this end in view, the writer, realizing that many in Idaho have had no experience in the production of corn, will briefly discuss the corn plant and its production and the methods whereby corn may most rapidly be adapted to a new environment and improved in both yield and quality.

In this great work that is before us,—a work that will be of incalculable value to the State, and which will by no means be limited by state lines,– the best and quickest results will be attained if all interested will work together. That this may be done, there must necessarily be a central organization which will be, as it were, a clearing house for the exchange of ideas and experiences, and for the purpose of collecting, classifying and publishing data relative to the work in hand. By virtue of the purpose of its organization, the Department of Agronomy of the Agricultural Experiment Station should act in this capacity. To facilitate this very work the Agronomy Department has organized a line of extension work known as the Idaho Agronomy Association. Its membership is composed of those interested in the improvement of agricultural conditions throughout the State, with particular reference to the production of crops. The principal work of the Association at present is to promote the increasing interest in corn growing. Last December a very successful corn show was held during the annual convention of the Association. (See Fig. 1). Everyone interested in this work should write to the Agronomist for further information.

II. THE CORN PLANT

1. Origin

As to the origin of the corn plant, there is a general agreement among authorities that it developed among tropical or sub-tropical conditions. As to the hemisphere in which it originated, there has been considerable discussion, but the consensus of opinion among the botanists of today is that it originated in America. The eminent French botanist, De Candolle, after considering the evidence relating to its origin, says,– "From all these facts, we conclude that maize is not a native of the old world. It became rapidly diffused in it after the discovery of America, and this very rapidity completes the proof that, had it existed anywhere in Asia or Africa, it would have played an important part in agriculture for thousands of years." He then goes on to show the greater antiquity of corn in America. He says that when America was discovered it was a staple crop from the La Plata to the United

PLATE I.

Exhibit of Corn at Agronomy Association Convention.

States; had names in every native language; and was found in the tombs of the Mound Builders of North America, the tombs of the Incas, and in the catacombs of Peru. He further mentions its connection with the religious ceremonies of the ancient Mexicans and Peruvians, and argues from this a very great antiquity in those regions for it to have become so supremely important. The fact that there was a number of varieties of corn in America when the European came, also points to a long period of cultivation previous to that time. De Candolle inclines to the belief that New Granada was the original home of the corn plant.

Since the discovery of America, corn has been carried to practically all parts of the world where the conditions are at all favorable to its growth; and we may expect that, during the present century, it will be taken to many more.

2. Description

Corn is a member of the great family of grasses, botanically known as *Gramineae*. In this same family are found all of our cultivated cereals,– wheat, barley, rye, oats, rice, etc. The scientific name of corn is *Zea mays L.*, more commonly spoken of as *Zea mays*, simply. Columbus found it called "mahiz" on the Island of Hayti. The early European colonists of America called it Indian corn to distinguish it from other cereals, which in the old world were given the general name *corn*. In the United States it is at present almost universally known as corn.

Corn is one of the few plants of which there is but one species in the genus. In is the only known representative of the genus *Zea*. De Candolle, referring to the effect of birds and rodents, upon its continuance and dispersion, says,– "Probably so unprotected a species was becoming more and more rare in some limited regions, and was on the point of becoming extinct, when a wandering tribe of savages, having perceived its nutritious qualities, saved it from destruction by cultivating it. I am more disposed to believe that its natural area is small, that the species is unique; that is to say, that it constitutes what is called a single-typed genus. The genera which contain few species, and especially the monotypes, have as a rule more restricted areas than others. Palentology will perhaps one day show whether there ever existed in America several species of *Zea*, or similar Gramineae, of which maize is the last survivor. Now, the genus *Zea* is not only a monotype, but stands almost alone in its family."

Corn is an annual quite susceptible to low temperatures, and its growing period must, in general, come between the late spring frosts and the early autumn frosts. It probably varies in size more than any other cereal. "The height is reported to vary from eighteen inches in the Tom Thumb pop to thirty feet or more in the West Indies," says Hunt. The temperature and moisture conditions greatly influence the height of a given variety, high temperature, and a plentiful supply of moisture causing a luxuriant growth.

When the seed germinates, a single central root pushes rapidly downwards, soon followed by several lateral roots which usually grow nearly horizontally a short distance and then turn downward. If the seed is planted too deep, a new whorl of roots will be sent out near the surface and the first formed roots will often slough off. The fine feeding roots branching off from the main roots nearly all remain near the surface. Roots often develop from the nodes near the ground and grow downward into the soil. These brace roots, or fulcra, as they are called, help support the plant. Their development seems to vary somewhat in different varieties, but seems more dependent upon the moisture conditions prevailing; the moister the growing season the more numerous and vigorous are the brace roots. This is fortunate, as they are more necessary when the soil is wet and yielding. Besides acting as braces, the fulcra often act as feeding roots.

At germination, the stem of the corn plant originates as a single, slender, pointed seed-leaf or cotyledon, for which reason corn is called a *monocotyledon*. It is said that, in rare instances, corn produces an abnormal kernel from which two shoots arise. The stem is usually simple but it is sometimes more or less branched, which indicates that corn was originally a much branched plant, probably bearing a branch at each joint or node. In general, the flint varieties are more branched than the dent varieties.(See Figs. 2 and 3.) A given variety will be lower and more branched where the climate is too cool for the best results. At each node a long slender leaf is borne, but those first formed do not last long. The natural tendency of the plant is to bear a leaf at each node and to develop a stem just above the base of the leaf, and the further tendency is for the lateral stems to branch in the same way.

The flowers of the corn plant are of two kinds, normally; one kind bearing the stamens or male organs and the other the pistils, or female organs. The former are borne in the tassel and the latter are borne at the end of a more or less elongated branch. The stamens and pistils not being borne in the same flower, the flowers are *imperfect*; and as the two kinds of flowers are borne on the same plant, the plants are *monecious*. Originally, the flowers were no doubt, *perfect*, (stamens and pistils borne in the same flower), and were borne at the ends of the central stem and lateral branches, somewhat in the form of the tassel of the present. Along the jointed branches or spikes of the tassel these flowers or spikelets were borne, two at each joint. The seeds or kernels were thus borne in pairs along slender spikes, were distinct from each other, and each one was probably enveloped in a thin husk-like covering. By a gradual process of evolution, aided very materially by man's care and selection, the highly developed plant of the present has been produced, with its hundreds of kernels closely packed upon a central axis, the cob. Botanists say that the ear has been developed through the fusion of the spikes of the tassel. As each spike bore a double row of flowers, the ear would have an even number of rows. Evidence as to the primitive habit of fruiting may be found in the tendency to revert to the same, which may often be seen by careful observation in a field of corn. All stages of development from single kernels to good-sized and well formed ears, may be found in the tassel. (See Figs. 4 and 10). This may be observed not only in the central tassel but at the extremities of long branches or suckers growing from the lower nodes of the central stalk.

The ear is produced at the end of a lateral branch, the *shank*, which may be long or short according to the degree to which the internodes elongate. It may be close against the stalk, or on a shank a foot or two long, or even on a sucker several feet long. As there is a tendency to branch and rebranch, so is there a tendency to produce ears at the ends of all these branches. The writer found, in a field of ordinary dent corn in Illinois, a corn plant bearing thirty-two ears of various sizes, including those only partially developed. (See Figs. 5 and 6.) Six ears were produced at one node of the central stalk of another plant, five of them arising from the nodes of the shank. (See Figs. 5 and 6.) The modified leaves of the undeveloped branch, being brought close together, are wrapped about the ear, constituting the husks. The ear varies much in form and size. Hunt says, "The ear may vary from *one-half inch to sixteen* inches long and may have *four to forty-eight* rows in individual ears."

The development of the kernel of the corn plant is very interesting, and a knowledge of the process, at least in its more obvious phases, is necessary to one who would work understandingly in improving a variety. A general description of the process will therefore be given.

The pistillate flowers are situated in rows along the cob. Each one contains a simple pistil. Within the *ovary*, or base of the pistil, is the *ovule*, which develops into the seed. The ovule consists of a central portion, the *nucellus*, and two coats, the *testa* and *tegmen*, or outer and inner integuments, enveloping the nucellus, but leaving a small opening, the *micropyle*, at the free end. One of the cells of the nucellus enlarges and becomes the *embryo sac*. Within this cell, as in all living cells, is a central body, or *nucleus*. This nucleus divides into *two nuclei*, one going to each end of the embryo sac, thus becoming the *polar nuclei*. Each of these divides into *two nuclei*, each of which divides making *four polar nuclei* at each end of the embryo sac. Then one polar nucleus from each group of four passes to the center of the embryo sac where they unite, forming a large nucleus, called the *definitive nucleus*, or *endosperm nucleus*. The three polar nuclei at the end of the embryo sac which is next to the micropyle

PLATE II.

are called the *egg apparatus*. One of these nuclei is called the *egg nucleus* and the other two are called the *synergids* (helpers). The other three polar nuclei are called *antipodal nuclei*. Attached to the tip or free end of the ovary is the long slender *silk*, which lengthens till it extends beyond the husks enveloping the ear. The part protruding is the *stigma*, on which may be seen very fine hair-like projections. Enveloping the young ovary is a thin husk-like covering which bursts and remains as chaff at the base of the enlarging kernel. (See Fig. 7.)

The staminate flowers are situated in pairs along the branches or spikes of the tassel. Each flower bears three stamens. The upper part of the stamen, the *anther*, is a sack-like body containing the male cells or *pollen*. As the anther develops, numerous cells are formed within it called *mother pollen cells*. Each of these develops into four pollen grains. Each pollen grain, being a living cell, contains a nucleus. This nucleus divides into two nuclei, one being called the *tube nucleus* or *vegetative nucleus* and the other the *generative nucleus*. The generative nucleus divides into two *sperm nuclei*. When the pollen is mature, the anther protrudes from the flower and a small slit or chink opens in its side, near its free end. From this opening, the pollen grains roll when the anther is shaken by the wind.

Pollination is the "transferrence of pollen from anthers to stigmas". When pollen of the corn falls upon the protruding portion of the silk, it adheres to the moist and sticky surface, the fine hair-like projections thereon helping to hold it. Under the moist influence of the surface of the silk, the tube nucleus develops a slender *pollen tube* which grows down through the spongy tissue of the silk*, enters the ovule, usually but not always at the micropyle, and terminates in the embryo sac. The tube nucleus is used up during this process, but the two sperm nuclei pass down the tube and enter the embryo sac. After pollination the silk dries up and dies, but remains in the husk until the ear is

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*It is thought by some botanists that the pollen tube may grow down the outside of the silk and enter the ovary at the STYLAR CANAL, an opening at the base of the silk on the side opposite the germ.

husked. The place of its attachment at the summit of the kernel may often be detected from the little scar remaining.

Fertilization is the union of a sperm nucleus with an egg nucleus. When the sperm nuclei enter the embryo sac, one of them unites with the egg nucleus and the fertilized cell resulting from this union develops into the embryo plantlet or germ, from which a new plant springs. The other sperm nucleus unites with the endosperm nucleus, this union being known as "double fertilization". From the cell resulting from this union, is developed the endosperm, which comprises the greater part of the kernel. The remaining parts are the *germ*, the *hull*, and the *tip cap*. The hull consists of the ovary wall, the two coats of the nucleus, (one or both may have been absorbed), and a layer of nucellus, all very much compressed, usually making a nearly transparent covering.* The cap at the tip sometimes remains on the cob when the kernel is removed. The kernel is thus composed of the *seed*, or matured ovule, and its coats, and the thin adhering wall of the ovary, being therefore a *fruit*, properly speaking. Without fertilization, no kernels of corn can be produced.

**The structure of the mature kernel is interesting. After soaking a kernel until it softens slightly, it may be separated into the following parts:-*tip cap*, *hull*, *horny gluten*, *horny starch*, *white starch*, and *germ*. (See Fig. 8.) The *tip cap* and *hull* have been noticed above. The *horny gluten* (aleurone layer) lies next to the hull and consists of a thin layer of relatively large cells. It is the outer layer of the endosperm. It usually contains a higher per cent of protein than any other part of the kernel. The *horny starch* lies in the sides and back of the kernel just beneath the aleurone layer. The *white starch* lies in the central part of the crown, or large end of the kernel, and also forms the bed of the germ. It is more or less completely divided near the center of the horny starch, the upper portion being called the crown starch and the lower portion the tip starch. In high-protein corn the

*The coloring matter of the kernel is usually in the layer beneath the hull, but in red corn, at least, it is in the hull.

**Adapted largely from Illinois Bulletin No. 87.

white starch is largely replaced by horny starch, this being particularly true of the tip starch. The *germ* lies in the lower central portion of the face of the kernel. It consists of two principal parts, the *scutellum* and the *hypocotyl*. The scutellum is a modified cotyledon or seed leaf, and is the absorbent organ which takes the prepared food material from the endosperm and transfers it to the embryo plantlet. The upper part of the hypocotyl is the *plumule* or embryo stem, and the lower part is the *radicle* or embryo root. The germ contains the greater part of the oil of the kernel and is very rich in protein.

The following table shows the approximate portions of the several parts of the kernel and their approximate composition. It is based on the analysis of a low protein ear (L. P.) and of a high protein ear H. P.):-

Composition of Corn Kernel *

Name of Part	Per cent of Kernel		Protein per cent		Oil per cent		Carbohydrates per cent		Ash per cent	
	L. P.	H. P.	L. P.	H. P.	L. P.	H. P.	L. P.	H. P.	L. P.	H. P.
Tip Cap	1.2	1.6	7.4	4.6	1.2	2.0	90.6	91.5	.9	1.9
Hull	5.5	6.1	5.0	3.8	.9	.8	93.3	94.3	.8	1.1
Horny Gluten	7.8	9.9	19.2	24.6	4.0	4.6	75.9	69.1	.9	1.7
Horny Starch	29.6	33.8	8.1	11.0	.16	.22	91.5	88.6	.18	.21
White Starch { Crown	16.9	10.5	7.2	8.6	.2	.5	92.3	90.5	.3	.4
White Starch { Tip	10.9	6.2	6.1	7.3	.3	1.4	93.3	90.8	.3	.6
Germ	9.6	11.9	19.9	19.6	36.5	33.7	33.1	36.7	10.5	10.0
Whole Corn			9.3	12.9	4.2	5.4	85.1	80.1	1.4	1.7

While the various varieties and types of corn are considered as belonging to a single species, yet there exists such a wide variation that the classification proposed by Sturtevant is very convenient. He separates the botanical species, *Zea mays*, into six "agricultural species" as follows:- *Zea indentata* (dent corn),

*Adapted from Illinois Bulletin No. 87.

Zea indurata (flint corn), *Zea saccharata* (sweet corn), *Zea everta* (pop corn), *Zea amylacea* (soft corn), and *Zea tunicata* (pod corn). The first four types are well known and are all grown in parts of Idaho. Soft corn is raised to some extent in the South. Its endosperm is wholly "white starch." Pod corn is rarely grown and is of no commercial importance. In addition to having its husks envelop the ear, each kernel is enclosed in a husk or pod.

We believe that the above paragraphs will furnish the basis for a rational understanding of the principles pertaining to the production and improvement of the corn plant, and we shall now consider these phases as briefly as is consistent with a correct understanding of the same, basing the discussion, in general, upon the more commonly grown dent type.

III. PRODUCTION OF CORN.

1. Soils and Moisture.

The soil best suited to corn is a rich, deep, friable loam, with a subsoil open enough to permit proper drainage and the extension of the deep-growing roots, but not so open as to dry out too rapidly. The greatest hindrance to successful growth is too much soil water in the early stages of growth and the resulting lack of soil air. The roots are thus compelled to develop too near the surface, and in the dry time later in the season the plant suffers from lack of moisture.

In a section where the surface is rolling or hilly and the precipitation is sufficient to cause the soil to wash, the richest soils are deposited on the lower levels. Bottom lands and reclaimed swamps are thus generally well adapted to corn, other conditions being favorable. However, corn adapts itself to various types of soils and may be grown with profit on most ordinary agricultural soils.

Soils that are light and deficient in fertility elements may be improved by the addition of coarse organic matter. This may be efficiently and economically done by green-manuring; that is, by plowing under certain growing crops, as rye, clover, etc.; or by the application of farmyard manure. Next to the application of

PLATE III.

Fig. 3. Varieties of Flint Corn. (Grown at Experiment Station.)

farmyard manure as a top-dressing upon grass lands, it can probably not be used to better advantage in a rotation than just preceding a corn crop, as corn is a good "foraging crop." Soils that are heavy and cold may also be made more suitable for corn by the above means.

As corn, in common with other cereals, is a nitrogen wasting crop, getting all of its nitrogen from the soil, it should be in a rotation with some nitrogen gathering crop; that is, one able to take nitrogen from the inexhaustible supply in the atmosphere. The only crops available for this purpose are the legumes or pod plants, such as clover, alfalfa, field pea, cow pea and soy bean. Under certain conditions a legume takes but a portion of its nitrogen from the soil, the greater part being taken from the air by means of bacteria living in small tubercles or nodules on its roots. If these nodules are not present during the growing season, the legume takes all of its nitrogen from the soil.

Corn being a rapid grower, a large supply of readily available plant food is necessary. The soil, therefore, should be put into excellent condition before planting time. Lack of preparation of the soil before planting can not be atoned for by extra work afterwards. Where the winter precipitation is light or the soils do not run together readily when wet, plowing may often be done profitably in the fall. Freezing and thawing improves the tilth of the soil, and the moisture of precipitation is more readily absorbed and held. Fall plowing may be deep,– eight to twelve inches or more. Where precipitation is light, deep plowing should be the rule, even to sub-soiling under the arid and semi-arid conditions. A greater reservoir for soil moisture is thus provided, and the roots of the corn are encouraged to strike toward the sub-soil during the early stages of its growth. Spring plowing should be rather shallow, as the time before seeding will be too short for the proper physical and chemical changes to take place in the raw soil brought to the surface by deep plowing. This distinction is much more important in humid districts than in the arid districts, as in the latter the raw soil is farther below the surface, and there is not the same demarcation between soil and sub-soil.

Where the question of moisture is the principal problem, great care should be taken to retain the moisture that is absorbed by the soil. Under such conditions, the loss is almost wholly due to evaporation and surface drainage, principally the former. Loss of "run off" water can be largely prevented by keeping the surface rough, as by plowing. Loss of "fly off" water, that lost by evaporation, can be very much lessened by interposing a loose, dry layer between the moist soil and the atmosphere. While various materials can be used for mulches on a small scale, as in gardens, the only feasible plan in field practice is to form the mulch of the soil itself. To accomplish this it is necessary to keep several inches of the surface fine and loose. A good mulch of this kind will almost entirely prevent loss of moisture by evaporation. The efficiency of the dust mulch is destroyed by a rain, and it should be renewed as soon afterwards as the soil can be properly pulverized. Water that escapes by percolating through an open sub-soil cannot be prevented from so doing, and it is well for a prospective buyer to have this in mind, when looking for a farm, and act accordingly.

The principles governing soil moisture are essentially the same under humid conditions and under arid conditions. What the plant needs is a certain amount of water available to its roots, regardless of whether it comes direct from the clouds or by way of the irrigation ditch. If there is too little, it suffers; if there is too much, it suffers. Where man has control of the water supply, the latter condition is apt to prevail, perhaps because he believes that "if a little is good, more is better". Even under irrigation, the practice discussed above should be pretty generally followed before planting time and the water withheld as long as possible. If the soil can be saturated to a considerable depth by winter irrigation, or very early spring irrigation, and a soil mulch formed, further irrigation will not be needed for a considerable time after planting, with the possible exception of a light application at planting time, in some cases, to germinate the corn quickly. The writer can see, from his office window, hill after hill where a crop of corn can be grown without a rain after planting time, provided the *dust mulch* is maintained; and provided, of course, that the winter *irrigation direct from the clouds* is sufficient, as it usually is.

A gentleman prominent in the affairs of Latah county recently told the writer that he had harvested a crop of fall wheat averaging fifty-two bushels per acre, and that it had received no rain after April 29th.

Mr. Campbell, by his system of "dry farming", has given prominence to the fact that much less water is needed for the production of profitable crops than has ordinarily been thought necessary.

2. Planting.

Having noticed briefly the general principles relating to the soil and its treatment before planting, we shall now give attention to the principles relating to planting.

The *time of planting* will of course vary considerably in the various parts of the state, and it will vary from year to year in each locality as well. The extremes will not be far from the first week in May and the second week in June, the usual time being the latter half of May. In general, it is best to wait until the soil is moderately warm before planting, as the seed will germinate more satisfactorily, and the subsequent growth will be more rapid than when the soil is cold. If the soil is cold and wet, the chances are that the stand will be poor, as a result of the rotting of the seed. Cold, damp weather before the corn is up is often more injurious than a sharp frost after it is up.

The *thickness of planting* depends upon the *soil*, the *variety* of corn, and the *use* for which the crop is intended. A soil fertile, of good tilth, and well supplied with moisture can support a much heavier planting than one that is deficient in plant food, is of poor tilth, and is lacking in moisture; a variety of corn that is low and has a scant foliage may be planted thicker than a tall, heavy-foliage variety; and a crop desired for forage or silage may be more thickly planted than one desired for the ears, the latter being particularly true when seed corn is the main object.

Thickness of planting may be modified by the distance between the rows and in the rows, and by the plants being separate from each other or grouped into hills of two or more plants. The most common method is to plant in rows about three feet and six inches apart with two or three kernels to the hill. If the field is foul with weeds, the method of checking is almost imperative, in order that the corn may be cross-cultivated. Aside from this, however, it is a good practice to drop kernels singly and from twelve to eighteen inches apart in the row. This gives each plant a better chance to develop its root system and to become more vigorous and symmetrical in growth. If corn were planted in hills three feet apart each way, an acre would contain 4840 hills. An average of one pound of ear corn per hill would yield a fraction over sixty-nine bushels per acre, at seventy pounds to the bushel. As many single plants are capable of producing a pound of corn, it is evidently not so much the amount of seed we plant as it is the quality that brings desirable results. A *perfect stand* of the *best corn obtainable* should be the aim of every corn grower.

As to the *depth of planting,* there is just one thing to be observed; namely, that the kernels be planted deep enough to germinate properly. A loose, well aerated soil will permit of deeper planting than a deep, clayey soil. In arid regions planting must be deeper than in humid regions, unless irrigation is practiced. It is said that on the arid plateaus of the West, the Indians sometimes planted corn over a foot deep in order to secure the requisite amount of moisture. Usually, deep planting is a detriment rather than an advantage. If the soil is wet, cold, and poorly aerated. the seed is very apt to rot; should it germinate, it will probably die before it can push its way to the surface; and even should it reach the surface, new whorls of roots will come out at nodes a short distance below the surface and the first-formed roots on the lower nodes of the stem will slough off, time and energy thus being lost at the most critical period of the life of the plant. Under ordinarily favorable conditions, one to two inches will be found to give the best results.

Whether planting is done by the common method on a smoothly prepared field, or by means of the lister, depends largely

PLATE IV.

Fig. 4. Types of Corn Tassels. (Selected at Experiment Station.)

upon the character of the soil its moisture content. Listing has not, as a rule, given good results in humid regions, as the seed, being placed in contact with the deeper and thus moister and cooler soil, does not germinate so readily. Furthermore, heavy spring rains may fill the furrows and injure the corn. In arid regions, however, listing usually gives very profitable results. Planting at the bottom of the furrow places the seed in contact with moist soil, and the gradual filling in of the furrow with dry, surface soil forms a deep and efficient soil mulch without injury to the plant. If the corn develops suckers, they may be almost entirely eliminated when several inches high by so filling in the dirt as to bury them.

Listing may be done upon unplowed ground, or the ground may be plowed beforehand, the latter preferably in the fall if conditions are favorable to such practice. Some farmers strike out furrows with the lister in the fall, and the ridges formed are split with the lister the next spring. The planting may be done with a combined planter and lister or with the common planter after the furrows are made, and the seed may be either drilled or checked.

3. Cultivating.

The principal effects of cultivation are *weed destruction*, *moisture control*, and *aeration of the soil*. To be efficient, cultivation must be done thoroughly and promptly. A few days delay at a critical period may result in a loss instead of a profit on the capital and labor invested.

A weed has been aptly defined as a plant in the wrong place; that is, any plant may be considered a weed if it is of no present use to the grower of a crop and hinders the development of the coop desired. Weeds are injurious in several ways. They may be so numerous and vigorous as to crowd upon a plant and deprive it of air and sunshine; they may appropriate the moisture and available plant food needed by the plant; or they may, by their presence in the harvested crop, injure its quality. The last mentioned result, however, is not apt to occur in the growing of corn, because of the large size of the individual plant and its seed. The soil should be thoroughly stirred before the crop is planted, in order that any weeds that have begun to grow may be destroyed. The early cultivation of corn may be done with a light smoothing harrow, or with a spring-tooth weeder. The first cultivation may be done just before the corn comes up, and subsequent cultivations should be frequent enough to keep the weeds from getting a hold in the soil.

The *control of soil moisture* is, as a general thing, the principal reason for cultivation; and this is particularly true where the moisture supply is apt to become insufficient for normal plant growth. Although cultivation may be done in such a way as to increase evaporation from the surface layers of soil, this is not to be regarded as one of its principal functions; but it is to be practiced chiefly as a means of conserving the moisture by retarding evaporation. The method of accomplishing this result by means of a dust mulch has been discussed above. The one essential is to keep a fine, loose, and dry surface layer several inches thick, to prevent the moisture from rising to the surface, where it would be evaporated. So long as it can be used, the weeder is an excellent implement for renewing a mulch that has been run together by a rain, and the field can be gone over quite rapidly. The depth of the mulch depends very much upon climatic conditions. Evaporation is more rapid in a dry atmosphere than in a moist one. Long days of excessively hot sunshine will result in such a heating of the mulch that the moisture in the soil beneath it will be turned to vapor, which will rise through the mulch and escape into the air. Under such conditions the mulch must be thicker than under ordinary conditions. Usually a mulch about three inches deep will be found sufficient, but it may be necessary, in some cases, to make it four or five inches deep, or even more.

The effect of the *aeration of the soil* by cultivation, though not so evident as the results discussed above, is none the less important. As was said above, corn requires a large supply of available plant food. One of the chief agencies in rendering the store of plant food in the soil readily available, is the action of certain soil bacteria which are not active in the absence of oxygen. A very important class of these organisms are the nitrifying bacteria, which cause nitrogen to become a part of compounds in which it can be used by the plant. Besides the above, the roots of the plant require a supply of oxygen in order to perform their functions. A constant supply of air is therefore necessary. The stirring of the soil by cultivation makes it open and loose and permits the circulation of air among its particles. A compact soil, and especially a puddled soil, hinders the entrance of the air into the soil, and finally causes the death of the roots and the death or dormancy of the micro-organisms mentioned above. Aeration also prevents or retards the action of certain soil bacteria which cause the loss of available plant food.

The *depth of cultivation* varies with the conditions of soil and climate. Shallow cultivation is now the most common practice. However, if the soil is a little too wet, deep cultivation with large shovels may give better results by favoring evaporation from the soil layer turned up. In any case, it is usually best for the early cultivations to be deeper than the later ones, in order to compel the roots to strike deep into the soil. Great care should be exercised not to destroy the roots of the plant by too deep plowing. The greatest injury from "root pruning" is apt to result from the later cultivations when the corn is growing rapidly and has developed an extensive root system to supply the large amount of moisture necessary. Within a few weeks after planting, the fine feeding roots have extended entirely across the space between the rows, and deep plowing destroys a large part of them. Then, too, as the season advances, the weather becomes hotter and drier and the supply of oil moisture is becoming less. The practice of setting the shovels to run deep and throw the dirt to the corn, making a series of ridges and hollows, both destroys the roots and causes a rapid drying of the soil, thus causing a two-fold injury.

The general principles controlling mulch formation, as given above, will usually determine the depth of cultivation.

There are several distinct types of implements used in the cultivation of corn. There are the walking and riding types; those for one, two, or more horses; and those classed according to the character of the teeth or shovels. The types last mentioned may be classed as broad shovel, narrow shovel, spike tooth, spring tooth, weeder, disk, and gopher. The broad shovel is not used so much as formerly, since the merits of level culture have begun to be appreciated. The weeder and spike tooth are much in favor for early cultivation, and the narrow shovel for later cultivation. The disk shovel is very little used as yet, although it is an effective implement, particularly in destroying weeds. The gopher type is very useful where weeds are to be destroyed and mulch formed. The shovels are long narrow blades set to run horizontally, or nearly so, just below the surface. There are usually two blades to each gang, set so as to overlap, the entire space between the rows thus being cultivated.

There is another implement, which, although not classed as a cultivator, is very effective in cultivating corn before it is out of the ground far enough to be injured; and it is particularly helpful in leveling the ridges where corn has been listed. The drag, planker, or boat is the implement referred to. Probably the most effective form is made by joining several planks so that their edges over-lap. The planker pulverizes the soil without packing it and at the same time destroys the small weeds that may have started.

4. Harvesting.

The time and manner of harvesting corn depends upon the use to be made of the crop and the character of the fall and winter climate.

If corn is to be used as green feed, it will of course be cut as needed. Unless it is much needed by the stock, cutting should be deferred until the tassels are out, as much more food is then available from the area cut than at an earlier stage. If fed to hogs, it is better to wait until the ears are near the roasting ear stage. Corn is sometimes planted quite thickly, even sown at times, for use as a soiling crop, and feeding is begun quite early to supplement the pasture.

When to be stored in the silo, corn should be cut when the ears are about full size and the stalk and leaves are still green.

Fig. 5. A Branched Corn Plant. (Grown in Illinois.)

This will be a short time after the roasting ear stage, when the dent stage is fully entered. If cut too early, there is not so much food material in the plant; and, besides, the silage is not apt to ferment properly and may spoil. If cut after the stalks and leaves have become dry, the silage is not so palatable. Silage is considered the most profitable form in which corn can be fed, as there is practically no waste.

If to be preserved as fodder, the corn should be cut as near maturity as can be done without loss of the foliage in handling. If deemed advisable to cut while the foilage is quite green and there is danger that the fodder may mold, the shocks or stooks should be made small, or partially built and allowed to cure several days and then completed. If the fall and winter is very rainy, it will often be found difficult to preserve fodder in a satisfactory manner.

The common practice of husking corn in the field should be commenced as soon as the ears are dry enough not to mold in the crib and should be completed as quickly as possible, before the fall rains begin, as the grain is very apt to be injured by wet weather. In order to keep satisfactorily in the crib, corn must be drier at husking time where the fall and winter are wet than where they are dry. It is sometimes necessary to make long narrow cribs or to provide some method of ventilation in the crib.

IV. SEED CORN.

Connected with corn growing there is no single factor of greater importance than the character of the seed planted. In the preceding discussion, the satisfactory quality of the seed was assumed, but we shall now give attention to the general characteristics pertaining to seed corn and to the principles controlling its selection and care.

1. Characteristics.

A. The Plant.

A proper discussion of seed corn is not possible without a consideration of the plant as a whole, as upon the character of the plant depends very largely the character of the succeeding crop. Two ears seemingly alike may give very different results when planted side by side, or the poorer of the two ears may give the better results. Strange as it may seem, a good plant may produce a poorer ear than that produced by a much better plant; that is, the ears may appear to be as stated. This result may be due to the different conditions surrounding the two plants; for example, the better plant may be so surrounded by other plants as not to be able to secure sufficient food and moisture to enable it to do what it is capable of doing under proper conditions, while the other may be where the stand is thin and so be able to secure a bountiful supply for its needs, thus being able to do better than it could do under normal conditions. This result may also be due to the fact that the better plant produced two ears while the other plant produced but one ear, which, though larger than either of the ears upon the better plant is not equal to the two combined.

Some desirable characteristics in the plant of a variety of corn raised for general purposes are these: A stalk of medium height, large at the base and somewhat rapidly tapering to the tassel, a broad leaf, an extensive root system, a moderately-sized normal tassel, and one or more well-protected ears, set at a convenient height above the ground.

The height of the stalk will depend much upon the variety and upon the conditions of soil and climate under which it is grown. However, it can be modified by selecting seed from plants of the height desired. A tall, slender stalk is apt to be blown over by the wind and is inconvenient to handle when cut for fodder or silage.

A broad leaf is desirable, as it is the leaf that the food elements coming in through the roots and leaves are made into a form that can be used by the plant. The greater the leaf surface, therefore, the greater the food supply available for the needs of the plant. The leaves have been called the stomach of the plant.

A well-developed root system is helpful to the plant in securing a sufficient supply of plant food and water and also by preventing its being blown over. The ability of the plant to withstand drouth should be taken into consideration in selecting seed, especially under "dry-farming" conditions.

There is such a wide variation in the types of tassels that some attention should be given to their size and general character. If the tassel is too small, an insufficient supply of pollen will result, and if it is exceptionally heavy, much of the strength of the plant is expended in developing the tassel and its pollen, which energy might better be used in the development of the ear. Abnormal tassels, as those bearing kernals or ears, are undesirable as they are tending to revert to the primitive type.

The position of the ear on the stalk is not only a matter of convenience in husking, but it also affects the ability of the plant to withstand wind; as, if the ears are set too high, the stalk is easily blown down. The husks should cover the ear so that it is well protected from birds, but should not clasp it so tightly as to hinder its development or make it difficult to husk.

B. The Ear.

The chief object in corn growing is to produce the largest amount of shelled corn per acre. Under given conditions of environment, the factors influencing such yield are the *size* of the ear, the *relative weight* of grain and cob, the *number* of ears per plant, and the *thickness* of planting. These factors, therefore, must all be considered if the comparative excellence of samples of seed corn is to be correctly determined.

As to the ear itself, the first two factors mentioned above, need to be considered. The proper size of the ear can be determined only when comparisons are made with consideration of the other factors. The writer believes it unwise to limit arbitrarily the size of the ear, as is commonly done in making of score cards. Of two ears, the larger is the more desirable, provided that, in other important characters, it is equal to, or better than, the smaller ears. Great care must be exercised as to this point, however, especially where it is difficult to get corn to mature because of early frosts. A large ear is usually longer in maturing than a smaller one. Furthermore, a large ear will not dry out so readily as a smaller one, and is more apt to mold if the autumn is rainy. About all that can be said that will be generally applicable in regard to the size of the ear is that the circumference, measured about one-third of the distance from the butt to the tip, should be *about three-fourths* of the length; or that the diameter at the same place should be about *one-fourth* of the length. Observation has shown that these values are approximately those of the best ears. In general, the most important of the two factors, under consideration is the weight of the shelled grain in comparison with the weight of the cob. An ear that is one-third cob is far less profitable than one that is only one-tenth cob, other things being equal. This being true, we shall next give attention to some characteristics in the individual ear that tend towards the production of a high percentage of shelled corn.

The most obvious point is that the cob should be small in comparison with the size of the ear. The diameter of the cob should be about one-half the diameter of the ear. A larger cob will result in a smaller percentage of grain and will cause the ear to be slower in maturing and drying out. The statement is sometimes made that a large cob will hold more grain than a small one. This may be true so far as the absolute weight of the grain is concerned, but it must be remembered that the cob is increasing in size as well. As a matter of fact, the rate of increase is generally greater in the cob than in the grain, as the depth of the kernel does not increase at so rapid a rate. Indeed, the larger cobs often bear shorter kernels than the smaller ones. If the depth of the kernels of two ears, alike in length and shape, is the same, but the diameter of the cob of one is *one-half* the diameter of the ear, and the diameter of the cob of the other is *two-thirds* the diameter of the ear, the cob of the first ear is *one-fourth* of the ear, while that of the other ear is *four-ninths* of the ear, measured by volume.

The shape of the ear should approach the cylindrical, as the kernels will then be more nearly uniform in size and shape, which is important as affecting a uniform drop by the planter. Then, there is more grain upon the ear, and the percentage of grain is apt to be increased as well.

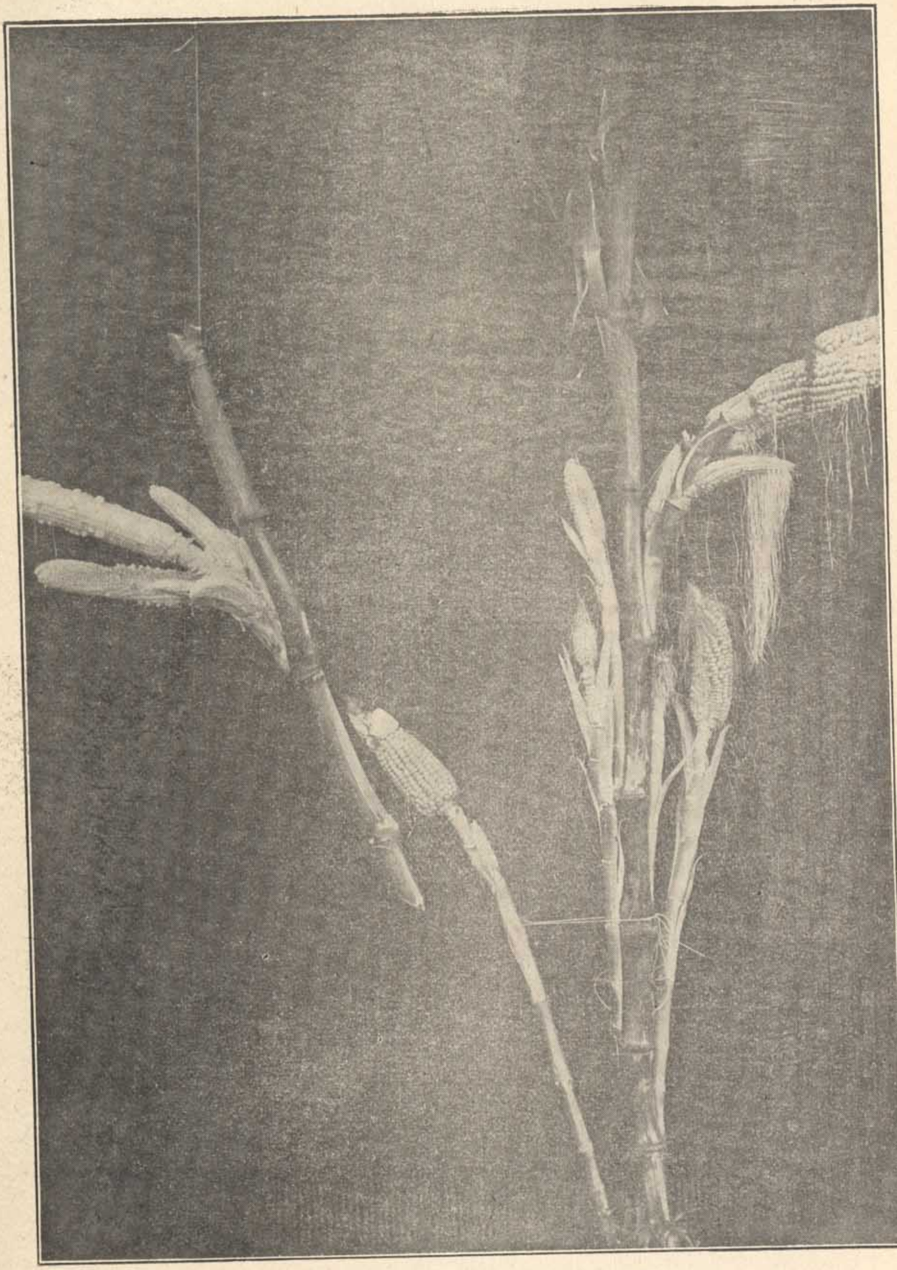


Fig. 6. A Branched Corn Plant. (Same as Fig. 5.)

The tip and butt should be cylindrical and well-filled with kernels of normal shape and size. The nearer this ideal is approached, the less waste will there be in "nubbing," or shelling off the ends of seed ears. Filling out will of course increase the percentage of grain upon the ear.

Another very important characteristic to be considered in the selection of seed corn is color. Any ear deviating from the variety color should be discarded, as this is usually a sign of a mixing of varieties. If but a single kernel is mixed, it may, if planted, scatter its pollen far and wide over the field and cause much trouble to the grower before he can rid his seed of the mixed corn. The color of the cob should be constant for a given variety. For example, white corn should have a white cob and yellow corn should have a red cob. Failure to conform to this requirement is considered due to the mixing of varieties.

Ears selected for seed should be as nearly alike as possible; that is, after one has decided upon the characteristics of his ideal ear, he should strive to have every seed ear conform to the ideal. This is "*uniformity*," which means likeness in *every respect*.

C. The Kernel.

There are several kernel characteristics that have a direct bearing on yield. They are *shape*, *depth*, and *space*.

Seen from the face, or germ side, the kernel should be wedge-shape with straight edges. This will permit the kernels to fit closely together, from tip to crown, and will prevent empty spaces between the rows. Viewed laterally, the face and back should appear parallel, which will prevent empty spaces between the kernels of a row. It will also necessitate a plump germ and a well-filled crown.

It is in the depth of kernel as compared with the size of the cob that the chief influence upon the percentage of shelled corn is found. In general the depth of the kernel should be equal to one-half the diameter of the cob.

In addition to what has been said about space in discussing kernel shape, it may be said that the furrows between the rows, and the spaces between the kernels in the rows should be well filled to the crowns of the kernels but should not be so close as to prevent the ready drying out of the ear.

2. Selection.

A. Preliminary Selection.

The preliminary selection of seed corn must be made in the field. Just as the silks begin to appear, one should go through the field and mark in some way the ears that begin to silk first, as at this time the relative earliness of ears can be told more accurately than at any other time. This process may be repeated at intervals of two or three days as long as desired. Shipping tags tied loosely to the stalk may be used as markers, the date being placed thereon, or the card may be numbered and a memorandum kept in a pocket note-book. Strips of cloth may be tied to the stalks as markers, a different color being used for each date. Where corn is often injured by early frosts, this early selection is very necessary, in order that earlier maturing corn may be produced.

When the corn is approaching maturity, the field should again be gone through and as many additional, desirable ears should be marked as are wanted. Attention to the characteristics of the plant should of course be given, and only those ears marked that are upon desirable plants. In this way, rapid and satisfactory progress may be made. When the ears are mature, they should be carefully husked, tagged and stored away. Where the climate is such that it is difficult to mature seed, it is a good practice to go into the field before a killing frost comes and cut the stalks bearing the earliest ears and place them in a sheltered but well-ventilated place to cure. The substance in the stalk will continue to enter the ear and cause it to continue to develop. Oftentimes seed can be obtained in this way when it would be impossible to obtain it otherwise. Care must be taken not to store the stalks where they will mold, as the seed will likely be injured.

If one does not wish to take the trouble to do as suggested above, he can at least nail a small box on the side of his wagon bed while husking his crop and drop into it the best ears from the best plants. In this way he will get better seed than not to select at all in the field, although he will of course do better by taking more pains. There are these advantages in selecting seed ears while husking; namely, that all the ears are handled, which gives a wide range of selection, and that environment and stalk characteristics can be noted with sufficient carefulness to prevent bad selections. The point we wish to emphasize is that some sort of field selection should be made, instead of selecting from the crib, as is too often done by corn growers.

B. Final Selections.

Passing for the present the discussion of the preservation of seed corn, we shall consider briefly the final selection of seed ears.

In field selections, not much attention can be given to the various characteristics that affect the quality of the seed, but during the winter, when farm work is not so urgent, more time can be given to the careful consideration of the selected ears. In the opinion of the writer, a properly directed study of several hundred ears of seed corn, during the short days and long evenings of winter, will be time well spent by the farmer and his family.

Each ear should be studied with reference to the points that have been mentioned under "Characteristics", considering the plant, (about which notes should have been made), the ear, and the kernel. This should be carefully done and the ears compared with each other. Some comparisons can be quickly made, such as shape and length, while others will require more time and careful observation. An ideal should be in mind and an effort should be made to find ears that will conform to the ideal. This means *uniformity*, the goal towards which our efforts should lead us. The few ears that most nearly approach one's ideal should be planted apart from the general crop, and the next year's selection should be made from the small crop they produce.

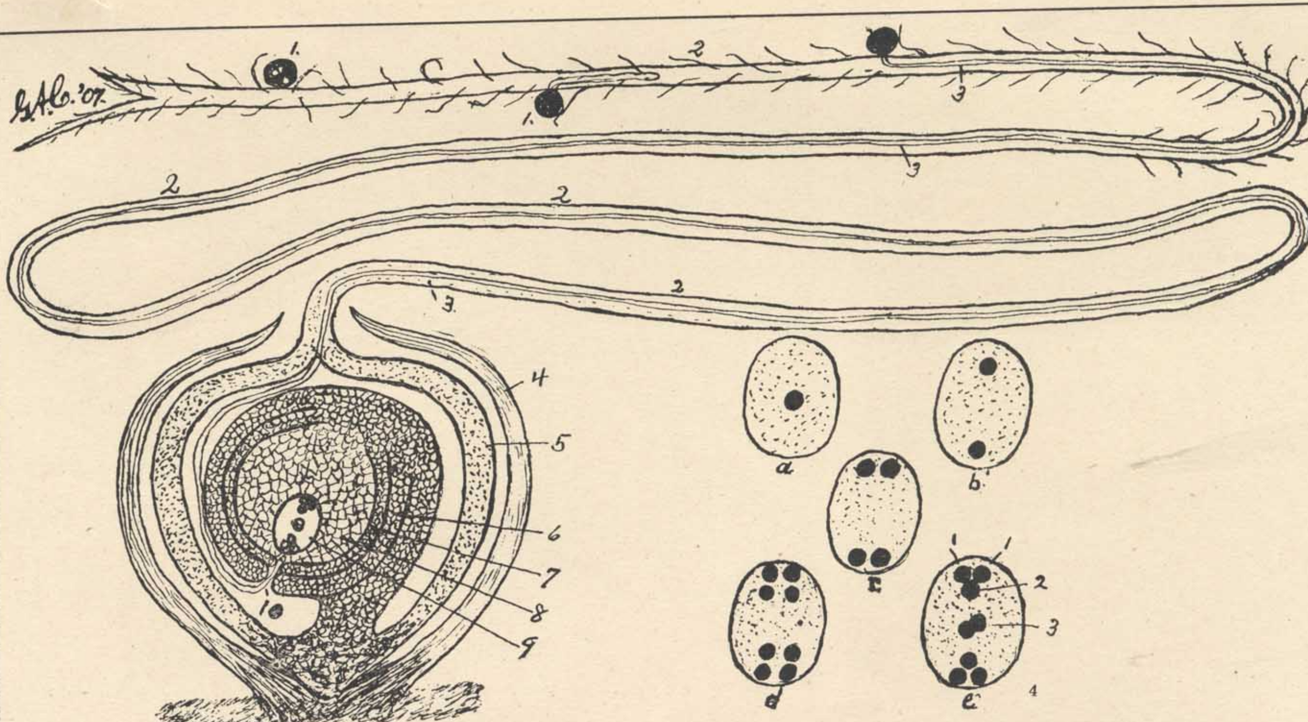
Above is given a general idea of the care that should be taken in the final selection of seed ears, if real improvement is to be made. He who does not wish to devote much time to this work, but is satisfied with ordinarily good seed, should at least select ears that are approximately alike, are of fair size and shape, and that have small cobs and deep kernels.

3. Preservation.

When the selected seed ears are brought from the field, they should be stored where they will dry out readily and be safe from injury in any way, especially from rats, mice, and fowls. If the ears are left upon the stalks, the latter should be placed in a protected but well-ventilated place where they will dry out quickly without moulding. In storing seed corn, quick drying to prevent injury from moulding or freezing must be accomplished even if it should be necessary to use artificial heat. Only enough heat is needed to keep the air dry.

The individual ears should be so stored that the air can circulate freely around them. They may be suspended from rafters, swinging scantlings, or stretched wires; or they may be placed in specially constructed drying racks. Knowing what is wanted, the thoughtful man can make some device from the means at hand. The writer has devised a portable drying rack which is easily made, is compact, and will give good results. It may be suspended, or set upon the floor. It is merely a wide board into both sides of which rows of long, small-headed nails are driven. A base of some kind should be attached so that the rack may stand if desired. The ears are forced upon the nails, the latter entering the pith of the cobs. (See Fig. 9).

For one who contemplates growing high-grade seed corn for the market, a specially constructed seed room will prove a profitable investment. The essential features are few. It must be proof against vermin and extremes of temperature, and must be well ventilated. Provision should be made for artificial heat to be used in facilitating drying in damp weather and to prevent injury from freezing in extremely cold weather. The ventilation should be so planned that the entrance of outside air can be regulated in damp weather. In such a room, seed properly harvested in the fall should be in perfect condition at planting time, and should command a good price.



Kernel,- early stage.

Embryo sac,- early stages.

1. Pollen grains.
2. Silk.
3. Pollen tube.
4. Kernel husk.
6. Testa.
7. Tegmen.
8. Nucellus.
9. Embryo sac.

1, 2. Egg apparatus.
1, 1. Synergids.
2. Egg nucleus.
3. Endosperm nucleus.
4. Antipodal nuclei.

4. Germination Testing.

Few people seem to realize the harm that is done by planting inferior seed. Should only one hill out of ten fail to germinate, the loss upon an acre of corn would probably be equal to the cost of seed and tillage for the entire acre. When we reflect that often from one-fourth to one-half of the seed fails to grow, the effect upon the profit received is easily seen. Even worse than the seed that fails to grow is one which sends forth a puny plant that appropriates food material that should have been used by its more vigorous neighbor and gives no harvest in return.

He who buys poor seed because he can get it at a low price, has failed to master one of the first principles of success in business. Let us examine such a case as applied to seed corn. We will suppose that we can get an excellent quality of seed from a reliable source at *three dollars* per bushel, and that we can get a poor quality of seed for *sixty cents* per bushel. Let us suppose that one bushel of seed will plant six acres, which is a low estimate. The cost per acre will be fifty cents for the good seed and ten cents for the poor seed. The good seed will thus cost forty cents more per acre than will the poor seed. One bushel extra per acre will pay the increased cost of the good seed. Does anyone think for a moment that there will be no greater gain than this? There will often be a difference of twenty-five or more bushels per acre.

It is true that, from various causes beyond our control, we cannot always get first class seed. We must then do the best we can, but we must always remember that the best is none too good. As one of the chief causes of poor corn crops is faulty germination, simple methods are here given whereby any corn grower may know to a certainty whether or not his seed corn will germinate satisfactorily; provided, of course, that the field conditions are favorable to such germination.

A. Conditions of Germination.

The essential conditions of germination are *viability*, *moisture*, *heat*, and *oxygen*. By viability is meant the ability of the seed to send forth a living plantlet. The vitality of seeds is affected in several ways. Age is a universal destroyer of vitality, but the period during which seeds remain viable differs widely among different kinds of plants. Oily seeds do not, as a rule, remain viable so long as do starchy seeds. Corn, therefore, may be expected to lose its viability sooner than would wheat, other conditions being the same. It is not best to plant corn more than two or three years old, although it will germinate when a number of years older. Corn in the ear will remain viable longer than will shelled corn, and an ear in the husk longer than a husked ear. Moisture is apt to injure the keeping quality of most seeds by enabling injurious moulds to develop and to injure the tender germ in the seed. Injury from freezing is more apt to occur when seeds are damp. Our ordinary agricultural seeds should be protected from moisture and extremes of temperature.

Moisture is essential to germination. So lono as the seed is dry, no multiplication of cells can take place within the germ, and consequently no growth can begin. The seed must become nearly or quite saturated with water before the life forces which are dormant in the seed can begin the process of germination. Too much moisture surrounding the seed is detrimental, as it is apt to make the temperature too low, or to prevent the ready access of oxygen.

Heat is essential to germination, the degree varying for different kinds of seeds. For each kind there is a *minimum* temperature, below which it will not germinate, an *optimum* temperature, at which it will germinate best, and a *maximum* temperature, above which it will not germinate. Corn has germinated at a minimum of 41 degrees and at a maximum of 122 degrees, but these germinations were of course very unsatisfactory. The optimum temperature for corn is near 100 degrees. Without a proper temperature, the chemical processes by which the stored up plant food in the seed is made available to the embryo plantlet will not take place, nor will the movement of the liquid contents of the cells, whereby the prepared plant food is distributed where needed be carried on properly.

Oxygen is essential to the carrying on of the life processes in the seed during germination. As the air contains an inexhaustible supply of oxygen, being about one-fifth oxygen, it is only necessary to allow the air to come into contact with the seed. Germinating seeds and growing plants may be said to breathe, as they carry on a process similar to respiration in animals, taking in oxygen and throwing off carbonic acid gas (carbon dioxid). In addition to this, however, green plants have the ability, when in the sunlight, to take in carbonic acid gas. Having briefly discussed the conditions essential to germination, we shall now give attention to some methods of making germination tests of seed corn.

B. Methods of Testing.

Our first problem in making germination tests of seeds is to supply moisture and air to the seeds in a proper amount and in a convenient manner. We can accomplish this by using any harmless medium which will absorb and retain moisture and not prevent the access of air. Soil, sand, or sawdust will meet the requirements very satisfactorily. A convenient and easily made germinator may be made by filling a shallow box nearly full of soil slightly moistened with water. To prevent too rapid drying of the surface several layers of papers or cloth may be laid upon the soil, or may be placed upon the top of the germinator and held in place by means of a board. Instead of a box, one may use a plate, a piepan, or a shallow cake tin, inverting upon the utensil used another to prevent excessive evaporation. If at any time the germinator becomes too dry, water must be applied. (See Fig. 11).

A modification of any of the above may be made by laying upon the soil or sand a piece of cloth, or unsized paper, pressing it close so that it will absorb moisture from below, and placing the seeds upon this. By this means the seeds are in plain view and can easily be counted in determining the percentage of germination. This method is particularly helpful in testing small seeds such as clover and alfalfa. There is the advantage, also, in this method, that the paper or cloth can be marked in numbered squares to facilitate the testing of individual samples of seed or ears of corn. If several thicknesses of cloth or paper are used to absorb moisture, the soil or sand may often be dispensed with. Instead of marking off spaces on a cloth or paper in testing seed corn, the cloth or paper may be dispensed with and the spaces marked off on the soil by means of a frame upon which strings are stretched, as shown in Fig 11. The kernels should be pressed tip first into the soil or sand until only the crowns are visible.

Having made the germinator, the necessary heat can be obtained by placing the germinator near the stove in the living room. It is not essential that the temperature remain uniform, but it should not remain below 60 degrees very long.

There are two general methods of testing corn; namely, by composite samples and by samples from individual ears. By the first method, several grains are taken from each of a large number of ears selected at random from the corn saved for seed. These grains are placed together in the germinator and the whole lot of seed used or rejected, according to the percentage of kernels germinating. This method is better than no test, but is faulty in that it makes no distinction between good ears and bad ears, a lot of seed sometimes being rejected that contains many good ears. The testing of the individual ears, however, enables one to discard the poor ears and preserve the good ears. Although this method takes more time and care, there is no farm practice that is more profitable for the time given. It is to the corngrower what the Babcock test is to the dairyman.

In testing individual ears it is necessary to keep track of the ears and of the sample grains taken from the ears. A numbered tag may be tied to each ear; the ears may be laid side by side on a board or table; long, small-headed nails may be driven into a board, or driven through and the board inverted, then numbered and the ears set upon them, the nails entering the pith of the cob; or the seed corn rack mentioned above may be used. (See Fig. 9). The kernels from each ear may then be placed in a correspondingly numbered square in the germinator. In this way it is easy

PLATE VIII

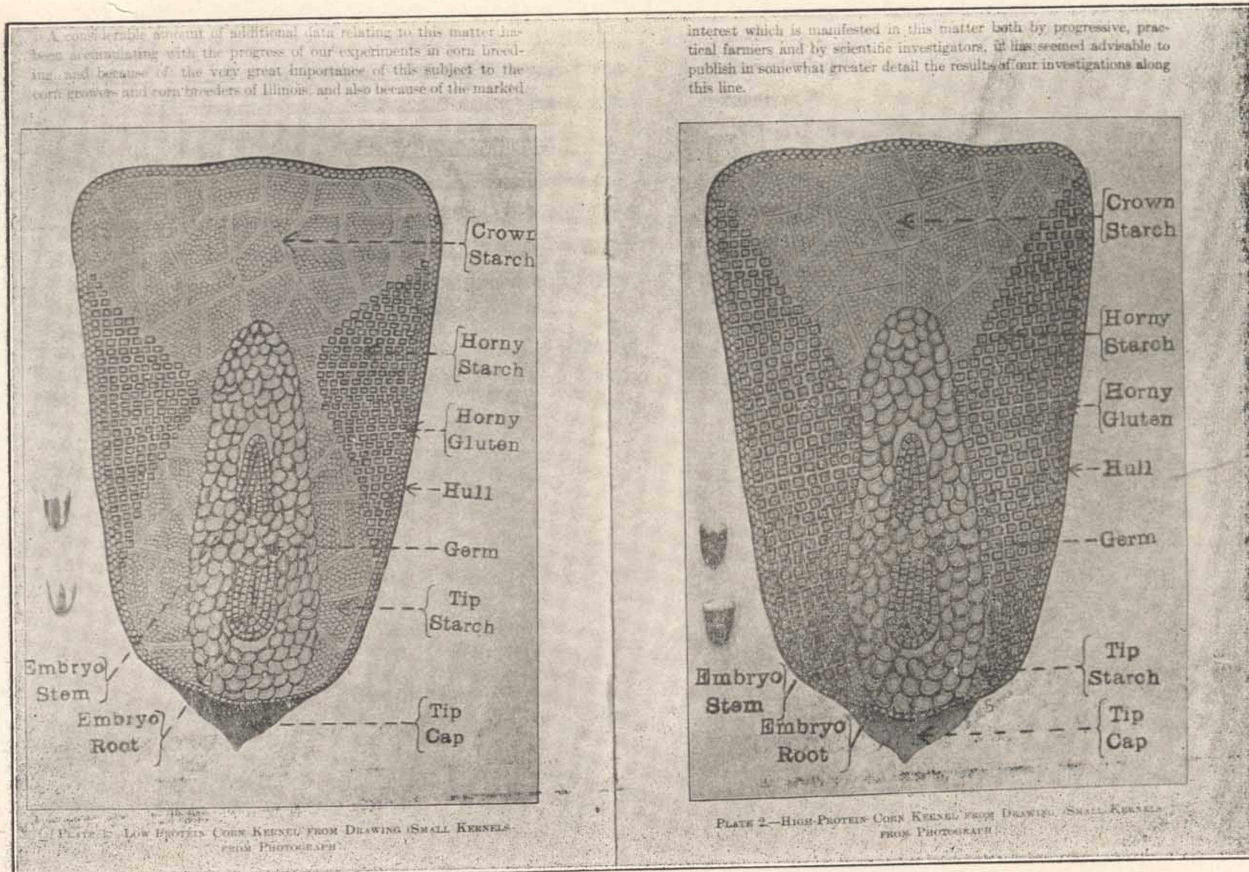


Fig. 8. Structure of Corn Kernel at Maturity. (From Illinois Bulletin No. 87.)

to discover and throw out every poor ear. When one reflects that an ear of corn is capable of producing from five hundred to one thousand plants bearing one or more ears each, it is evident how essential it is that only good ears be used as seed.

In taking kernels from an ear to be tested, they should be selected from various parts of the ear in order to represent the ear fully. Three to five kernels from an ear are usually considered sufficient, although some select ten kernels, probably because it is easier to determine the percentage of germination. However, instead of paying much attention to percentage in this case, it is safer to reject every ear of which even one kernel fails to germinate quickly and vigorously. At least, such an ear should be tested again before it is decided to use it for seed.

A convenient method of numbering the ears on the seed corn rack is to number the rows horizontally and vertically, writing numbers to the *left of the point* for the horizontal rows (1., 4.) and to the *right of the point* for the vertical rows (.3, .10). If more than one rack is used they may be designated by numbers written to the *left of a colon* (1: 6:). An ear on the fourth rack, in the twelfth horizontal row, and the fifth in the row would be numbered (4: 12. 5). The same method may be used for numbering the squares in the germinator and in a diagram in which a record of the number of kernels germinating is entered.

5 Corn Judging.

In the judging of exhibits of corn, the use of a score card has become quite common of late years. Although there have necessarily been many conflicting opinions as to the characteristics that should find place upon the score card and as to the relative importance of the characteristics selected, much good has come to the corn industry, where a score card has been in use. Attention having been especially directed to the desirable points of good corn, the corn grower began to study his product as he never had done before. The fact that these points would be considered in the judging of exhibits was an incentive to a careful study of the score card, as the exhibitor knew that upon these the decision of the judge would be based. Under the old system, the decision depended upon the opinion of the judge as to what constituted the most desirable qualities of good corn. As there was a considerable difference of opinion in this respect among judges, the result was a different basis of judging from year to year. This discouraged, rather than encouraged, the careful study of the characteristics of corn, without which no improvement can be made.

During the last decade, great progress has been made in the improvement of corn, and there are now numerous "standard varieties" adapted to various conditions. No doubt much of this improvement is due to the use of the score card by a rapidly increasing number of corn growers. We therefore recommend that the corn growers of Idaho make use of this device, in order that they may advance as rapidly as possible in improving their corn. As there is no uniformity as yet among the several score cards in use, it is necessary that we adopt one suited, as nearly as possible, to our conditions. With this in view the writer has arranged a score card as a suggestion of what may be used in the pioneer stage of corn growing in Idaho. This score card has been adopted by the Idaho Agronomy Association for use in judging exhibits at its annual meeting. As we study our varieties of corn and compare ideas, the score card will be modified from time to time.

Below are given the *Rules of Exhibit* in force last year, the *Score Card*, and *Rules of Judging*.

RULES OF EXHIBIT.

1. All *competing* exhibits shall be of corn grown in Idaho in 1906.

2. All exhibits must be sent to the Department of Agronomy, carefully packed to prevent any injury to the ears. As nearly as possible, they should be sent in during the week beginning December 3rd. If shipped, all charges must be fully prepaid to Moscow, Idaho.

3. All competing exhibits shall become the property of the Department of Agronomy, from which to select samples for the beginning of a permanent exhibit of Idaho corn.

4. Each exhibit shall consist of fifteen (15) ears, *five ears* to be used in the "shelling test" and the determination of kernel characteristics, and *ten ears* to be used in determining other points.

5. The judging of exhibits of dent corn shall be in accordance with the score card approved by the Executive Committee of the Association, the preliminary selections being made by means of the "shelling test" and the final selection being made by means of the complete score card. A modification of this score card may be used in judging the other classes of corn. Exhibitors will do well to notice the points mentioned in the score card, as it will facilitate the selection of an exhibit. (The explanation of the score card will be a part of the study of corn during the convention.)

6. Exhibits of stalks of the corn from which the ear exhibits are selected may be made to show fully the character of the variety. This exhibit should consist of *three stalks* dug up by the roots, (from which the dirt should be washed), and bound into a compact bundle.

SCORE CARD FOR DENT CORN.

The Ear.		
1. Shelling Test.......	20	Per cent of shelled corn.
2. Size Ratio.........	10	Circumference to length.
3. Shape............	10	Nearly cylindrical; rows straight and entire
4. Color { Kernel	10	True to variety.
Color { Cob........	5	Red for yellow; white for white.
5. Tip..............	5	Well filled.
6. Butt...............	5	Well filled
7. Uniformity	5	Same general appearance.
The Kernel.		
8. Shape............	5	Wedge shape; straight edges.
9. Depth	5	One-half diameter of cob.
10. Space	5	Well filled between rows and kernels.
11. Uniformity.........	5	Same general appearance.
Market Condition.		
12. For Seed..........	5	Mature, bright, firm; large germs.
13. For Mill..........	5	Mature, bright, firm, sound.

	100	

RULES OF JUDGING THE EAR.

1. *Shelling Test.* The shelling test is to determine what proportion of the ear is composed of the kernels. To determine this, divide the weight of the shelled corn from five average ears

PLATE IX

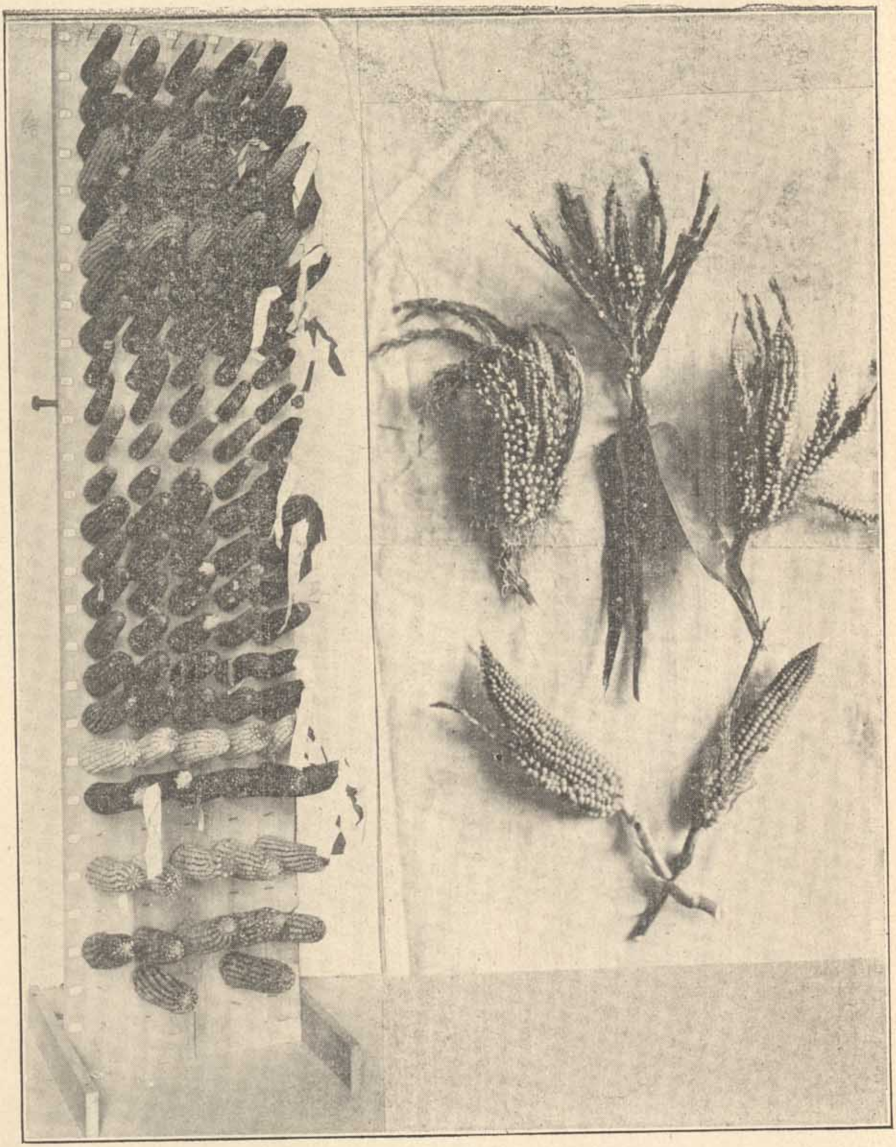


Fig. 9. Seed Corn Rack and Idaho Corn.

Fig. 10. Types of Reverting Tassels. (Selected at Experiment Station.)

by the weight of the entire ears, expressing the result in hundreths. For every hundreth above .90 or below .90 to .85 deduct *one point*, and for each additional hundreth below, .85 deduct *two points*.

2. *Size Ratio.* Divide the circumference by the length, measuring the circumference at one-third of the distance from the butt to the tip, and express the result in hundreths. The standard is from .75 to .80 (3-4 to 4-5). For each hundreth an ear is above or below the standard cut *one-tenth*.

3. *Shape.* Ears should be approximately cylindrical. The rows should be straight and entire. A full cut is *one point* per ear.

4. *Color.* (a) The color of the kernels should be true to the variety type; that is, it should not be mixed with corn of another color. For each mixed kernel cut *two tenths*, counting no further than five mixed kernels. (b) Yellow corn should have red cobs, and white corn should have white cobs. Cut *five-tenths* for each cob off color. (c) In judging exhibits entered as "mixed" or "miscellaneous", make no cut for color.

5. *Tip.* The tip should be cylindrical and well filled, bearing kernels of uniform size and shape. A full cut is *five-tenths* per ear.

6. *Butt.* The butt should be neither much contracted nor much enlarged. The rows of kernels should extend over the butt in regular order. Ill-shaped and glazed kernels are objectionable. The removal of the shank should leave a deep depression. A full cut is *five-tenths* per ear.

7. *Uniformity.* Uniformity means similarity in appearance and has no reference to quality. A full cut is *five-tenths* per ear.

The Kernel.

8. *Shape.* Kernels should be wedge-shaped with straight edges, as seen from the germ side. When viewed from the lateral sides, the edges should be parallel. This will necessitate a plump germ and a well-filled crown. A full cut is *five-tenths* per ear.

9. *Depth.* The kernels should be long in proportion to the

diameter of the cob. In general the length should be fully one-half the diameter of the cob. A full cut is *five-tenths* per ear.

10. *Space.* The furrows between the rows and the space between the kernels in the rows should be well filled to the crowns of the kernels, but should not be so close as to prevent the ready drying out of the ear. A full cut is *five-tenths* per ear.

11. *Uniformity.* The kernels should be uniform in general appearance, and particularly in respect to size and shape, as the latter affect the rate of dropping and the consequent stand. A full cut is *five-tenths* per ear.

Market Conditions.

12. *For Seed.* Good seed corn should be mature, bright and firm, and should possess a large, plump, vigorous germ. A full cut is *five-tenths* per ear. (Where practicable, a germination test should be made in determining this characteristic. When this is done ten grains should be taken from each of five ears and a cut of *one-tenth* made from each kernel failing to germinate vigorously in three days under favorable conditions.)

13. *For Mill.* Good milling corn, (which is also good feeding corn), should be mature, bright, firm and sound in every way. It should be free from dirt, and rotten, moldy, or broken kernels. A full cut is *five-tenths* per ear.

V. IMPROVEMENT OF CORN.

1. General Principles.

In the discussion of the improvement of corn there are certain principles that deserve consideration, which are of general application in the realm of plant life. A brief statement of the more important of these principles is all that can be given here.

A. Four Great Laws

There are four great laws concerned in the evolution of plants, —the laws of *heredity*, *variation*, and *natural selection*.

In accordance with the law of heredity, a plant tends to repeat itself without change in its offspring. This is sometimes expressed as, "Like produces like". If it were true that the offspring were an exact reproduction of the parent plant, there would be no possibility of either degeneration or improvement. However, we know that the offspring of plants do differ from the parent forms; and furthermore, that no two plants have been found to be exactly alike. Therefore, under this law we may expect, not perfect likeness, but that a plant will, in general, produce offspring more or less closely resembling it.

The law of variation may be considered the counterpart of the law of heredity, as it includes that which the latter fails to comprehend. According to this law there is a continual variation in progress among plant forms, whereby the offspring always differs from the parent, and may or may not be an improvement. Variation may result from the inherent tendency of the plant to vary, or as the effect of crossing, by which new combinations of characteristics arise from the union of two individuals.

Atavism, or reversion, refers to those cases in which a plant resembles a distant ancester more closely than it does the immediate parent plant. This resemblance may be due to the reappearance of one or more characteristics that were possessed by the older form but had become dormant, or to the disappearance or dormancy of characteristics which had been acquired and which distinguished the new form from the old. According to DeVries, much that passes for atavism is not true atavism but is the result of crossing, true atavism being very rare. He proposes the term *vicinism* for these cases of apparent atavism.

Natural selection determines how many and what forms of plant life shall persist. There is not space for the multitudes of young plants to develop to maturity. The result is a struggle for existence, by which the weaker forms are crowded out and only comparatively few stronger forms, or those best adapted to their environment, reach maturity.

B. Plant Breeding.

In the practice of plant-breeding, man must work in harmony with the laws of plant life as found in nature, directing and modifying them as best he may. His purpose in so doing is to produce plants that are better suited to his wants and conditions than are those in the wild state. By freeing a plant from the necessity of struggling for existence, he may induce it to expend its energy in improving, in quantity or quality or both, some part that he desires for his own use. Corn is an excellent example of this, as is shown by the greatly increased yield of grain as compared with the yield of corn of earlier times.

From the great number of variations arising in a collection of plants, man may, after careful examination, find an individual plant that suits his needs better than any other one of the whole number examined. It may not be the best fitted to survive under the conditions surrounding it, and therefore not able to develop under the rigor of natural selection, but it does have some quality that is desirable to man. Therefore, he will remove it or its seed to a more favorable environment or make its immediate environment more favorable. Natural selection and artificial selection are along very different lines, the plants selected by man being less rugged than those surviving in nature. Cultivated plants, therefore, require constant care, but in return they develop the characteristics desired by man.

Plants may be induced to vary more rapidly than is usual in the natural state, if certain changes are made in their environment. Two important modifications of environment are variation in food supply, and change of climate. Variation in both quantity and quality of food supply may result from the removal of plant food by cropping, variation in the amount of space occupied by the individual plant, the character of tillage operations, the application of fertilizing materials, and removal to a different soil. By change of climate is meant, not the change at a given place, but the change encountered by transferring the plant or seed to a region having different climatic conditions. If the change is too abrupt, the plant will perish; but if it is not too great, the plant will gradually adapt itself to the new conditions. After a plant has become adapted to new climatic conditions, it may then be transferred to a more exacting climate, where it could

PLATE X.

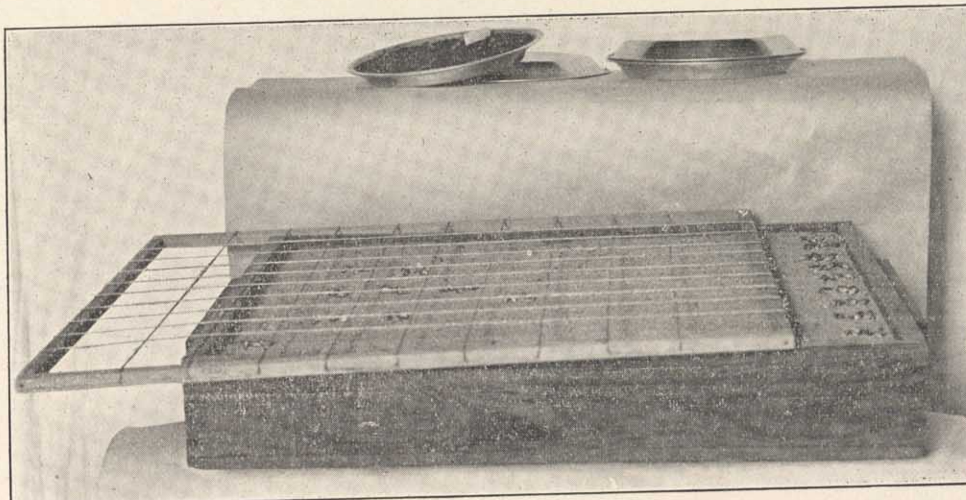


Fig. 11. Seed Corn Germinators.

not have survived before its adaption to the intermediate conditions. This is well illustrated in the gradual advance of corn from Central America to Canada. This is the method, too, that will have to be followed in adapting corn to many parts of Idaho. In some parts of the State, corn brought from the "Corn Belt" states will give good results when first introduced, while in other parts it will fail to set ears. It may be said here that a given individual plant has little power of adaption to a new environment, but each succeeding generation is better adapted to its surroundings than the preceding one.

By crossing two plants, numerous and great variations are often produced, giving the breeder a wide range in selection. The generations following a cross are often very unstable; and if a desirable form is found, it is apt to be lost in succeeding generations. The process of making an unstable form permanent or stable requires care and judgement on the part of the plant breeder. As a rule, crossing to obtain new forms is not desirable, the improvement of existing forms by careful selection being the better practice. This is particularly true of corn, of which there is a great number of varieties. What is needed is for these varieties to be improved and adapted to our various conditions by careful selection. Corn, being a wind fertilized plant, will mix if different varieties are planted near each other. The distance pollen will carry depends upon the velocity of the wind and freedom from obstructions, such as hills or trees. Under ordinary conditions, if it is desired to keep a variety pure, it is best to have it at least eighty rods from any other variety, and it is better if the distance is even greater. If it is desirable to let one variety cross upon another without itself being crossed by the other, the tassels of the second variety should be *pulled out* as soon as they begin to appear. This will prevent the development of pollen by the second variety and it will be fertilized by pollen from the first variety.

2. Practical Methods.

A. Making a Start.

When one has decided to become a corn breeder, he should determine to profit as much as possible by the work that has already been done in this line. While it is possible to improve a poor variety, it is very unwise to spend years of one's life in doing so, when there are so many excellent varieties in existence. The proper course is to begin with as good a variety as can be obtained, which of course includes adaptability to the conditions under which it is to be grown, and then to improve that variety as rapidly as possible. If one cannot obtain what he considers a good variety to begin with, he should begin with what he can get and not lose a year while sending for his ideal. The important thing is *to start now*. If another variety is obtained afterwards which *proves itself to be better* than the one first chosen, it should displace the old one.

When a variety has been chosen, one should have clearly in mind the character of the improvement he desires to effect. A definite ideal is essential if progress worthy the name is to be made. Selections may be made for improvement in any or all of the following:—adaptation to environment, physical characteristics, and chemical composition.

B. The Breeding Plat.

In undertaking to improve a variety of corn, some system must be adopted and faithfully followed. The better the system the more satisfactory is the progress made. That system is best which gives the breeder the best control of his plants, makes possible the most nearly accurate comparisons, and provides for the most convenient record of essential data. Very complete systems have been devised for the use of the corn breeder. The writer will endeavor to present as briefly as possible the essentials in a simple system that may be used by every corn grower.

The first essential is to select for a breeding plat a piece of ground that is as nearly uniform as possible throughout, and is a sufficient distance from any variety of corn other than the one to be grown. If it can be beyond the reach of pollen from the general field of the same variety, the possibility of fertilization from inferior plants can the better be controlled. In this plat the few very best seed ears on hand should be planted, each ear by itself so that they can be compared with each other. From this plat will be chosen the select seed ears for the next year. The remaining seed ears may be shelled together and used for planting the general crop or for sale as seed corn.

There are two general methods of planting the individual ears in the breeding plat. They are known as the "plat" system and the "row" system. They are briefly discussed below.

C. The Plat System.

In using the plat system, the breeding plat is laid off into small squares, or into rectangles approximately square. For this reason, it may be spoken of as the *square* system. These small plats are usually ten hills square, although they may well be made larger. Each square is planted from a single seed ear. This method provides for the maximum of fertilization among the plants from the same ear. The tendency of this is to limit variation and make possible the more rapid fixing of characteristics. It is advocated by some investigators that fertilization among corn plants so closely related will result in degeneration. However, there will be some fertilization by pollen from neighboring squares, which will modify the possible danger. If it is desired to prevent as much as possible the access of pollen from any other squares, a number of rows may be planted between adjoining squares and the plants in these rows detasseled. If a tall, heavily foliaged fodder corn is used for this purpose, much of the pollen from the surrounding squares will be stopped.

D. The Row System.

The row system, in which each ear is planted in a single row, differs from the plat system chiefly in favoring fertilization among plants from different ears rather than among those from the same ear. Planting is more conveniently done by this method, even if done by hand, but much more so if done with the large planter. Sometimes, instead of planting all of the ear in one row, it is planted in two rows at a distance from each other, in order that any difference in yield because of a difference in the soil may be taken into account.

Fertilization among plants from the same ear may be prevented by detasseling all the plants in alternate rows and selecting seed ears from the detasseled rows. If the entire ear were planted in a single row, it would prevent the selection of seed ears from one-half the number of rows, some of which might be from better seed ears than were the detasseled rows. This can be avoided by detasseling half of *each* row, detasseling, for example, the south half of one row and the north half of the next row, and selecting seed from the detasseled portions. By advising the selection of seed ears from detasseled rows only, we mean in selecting for the next year's breeding plat. The other rows will furnish good commercial seed or seed for planting the general crop if desired.

At the time of detasseling, whichever of the plat systems is followed, all barren and otherwise undesirable plants should be detasseled to prevent pollination from such plants.

The above outline of the two general methods of laying out a breeding plat will be sufficient to enable any one to make a proper beginning in the improvement of a variety of corn.

E. Harvesting the Breeding Plat.

As soon as the corn is mature, it should be harvested in order to be safe from bad weather. Whichever method of planting is followed, the yield from each row or square should be carefully husked, sacked, and labelled. If part of the row has been detasseled, the yield from that part must be kept separate from the other part. Ears that have been specially selected in the field before husking time should be marked in some way to distinguish them from the other ears in the sack.

Everything must be so carefully labelled that there will be no difficulty in determining later the exact conditions relating to any sack of corn. If this is carefully done, and sufficient records are

PLATE XI.

Fig. 12. Harvesting for the Silo and Effect of Frost.

kept in a pocket note-book, there will be no difficulty in studying the corn later.

F. Comparison and Records.

The yield from each row or square should be ascertained by weighing, and a record should be made of the weights. This is the first and most important comparison in determining relative excellence, as it is a measure of productiveness. It may need to be modified because of differences in environment, as soil, stand, etc., or by the relative amount of cob and grain. The yields of rows that are evidently inferior may be discarded at once and used for common seed or for feed.

Of the seed retained after weighing, the poorer ears may also be discarded at once, so that only the ears that are evidently good for breeding purposes are retained for more careful comparison. As time permits, the remaining ears may be carefully studied with reference to the characteristics previously discussed. The eye and the memory must not be depended upon too much, but a record should be made of essential points.

In the final selection of seed ears for breeding purposes, care should be taken that the ears be not taken from the same lot of seed, unless very close in-breeding is desired. It is better to select from the eight or ten best lots and not to plant closely related ears in adjoining rows.

If it is desired to select seed with reference to its chemical composition, it may be done by a little careful examination of the kernels. By referring to the table on page 15, it will be seen that the most of the protein is in the horny gluten, horny starch, and the germ. Therefore, if much protein is wanted, ears should be selected whose kernels have a large proportion of the dark-colored or horny parts and large plump germs, and a correspondingly small proportion of the white starch. This may be ascertained by splitting the kernels in different directions with a knife.

VI. CORN WORK AT THE EXPERIMENT STATION.

One of the chief lines of work begun by the writer upon assuming, in 1904, the duties of agronomist of the Agricultural

Experiment Station, was a study of the possibilities of corn as a profitable crop in Idaho. Taking up the work but a short time before the crop season and having no seed whatever on hand, the problem was indeed a new one, although corn had been grown at the Station for several years as a silage crop. The first phase of the problem was evidently the testing of varieties and strains from various sources for the purpose of determining what ones were best adapted to the climate and other conditions. This work has been carried on for three years and some progress has been made, while the indications are that corn may soon be grown with profit in many localities where it had seemed useless to attempt it. Below is given an epitome of the work carried on during the last three years.

1904.

In the spring of 1904 a number of varieties and strains of corn were selected for testing. Seed of several varieties that were being grown in a small way by several men in the vicinity of Moscow was obtained, and seed of a number of northern-grown varieties of the "Middle West" was donated by Northrup, King & Co., Minneapolis, Minnesota. Several varieties were obtained from other sources. In all, twenty-six varieties were tested.

The Experiment Station Farm was selected as the place for making the test. The site chosen is probably near the average as to conditions under which corn may be grown in this part of the State. It is by no means as favorable to corn growing as some other localities in this section as to soil and climate; nor, on the other hand, is it as unfavorable as some. It is thought that a variety of corn developed and improved in this locality will be easily adapted to much of Idaho.

The several varieties were given the same conditions as nearly as possible. They were planted in hills, the number of rows allowed to a variety varying from one to four, according to the amount of seed obtained.

Notes were kept on the development of the several varieties as the season advanced. As was expected, there was a wide variation among the several varieties. The principal points noted were the dates of tasseling and silking and the stage of maturity reached in the fall.

All varieties but one were planted *May 24th*. The first tassel made its appearance *July 20th*, and the latest variety began to tassel August 11th. The first silk was seen *July 27th*, and the latest variety to silk began about *August 27th*. A variety received later was planted *June 3rd*. It began to tassel *July 27th*. The time of the appearance of the first silk was not noted. It was not in the same field as the other varieties.

As killing frosts are apt to occur the first week in September, it was soon evident that a number of varieties could not develop seed. *September 8th* the earliest ears were selected from the four earliest varieties. In harvesting these ears, the stalk was cut with the ear upon it and laid in a dry place.

On *September 10th and 11th* two hard frosts occurred, which frosted the foliage of the corn. September 11th seed ears were again selected from the earliest varieties, and notes were made of the stage of maturity reached by each variety. Such varieties as it was thought might mature seed were left standing and the others were made into silage. At this time a number of varieties were still in the *milk stage* while only four had reached the *early flint stage*.

As a result of the summer's test, seed was saved from eleven varieties, nine being dent corn and two being flint corn. Five of the varieties from which seed was saved were from seed grown near Moscow. Only a few ears were obtained from each of the eleven varieties.

1905.

The corn work this year was along lines similar to those of 1904, being mainly a variety test. Seed was obtained from various resources. Fourteen varieties were received from the United States Department of Agriculture for a test in co-operation with the Department; twenty varieties were obtained from Northrup, King & Co.; four more varieties were obtained near Moscow;

four varieties were obtained from miscellaneous sources; and the seed saved from the eleven varieties in 1904 was planted. Allowing for duplicate varieties obtained from different sources, over fifty varieties were grown this year. The planting was done *May 29th and 30th.*

The season was not so favorable for corn as was 1904, because of a scarcity of soil moisture and a spell of very hot weather while the corn was tasseling.

The earliest variety began to tassel *July 20th* and the latest began *August 8th*. The first silk appeared *July 29th* and the latest variety began to silk *August 22nd.*

Besides the test for comparison of varieties, two varieties were tested for variation among the ears of the same variety. The seed from the individual ears was planted in parallel rows, one or two rows to each ear. Fifteen ears of yellow dent corn planted in this way showed a variation of *ten days* in the time of appearance of the first tassels and a variation of *nine days* in the time of appearance of the first silks. Fifteen ears of white dent corn showed a variation of four days in the time of appearance of the first tassels and a variation of six days in the time of appearance of the first silks. This shows the importance of selecting seed ears in the field if earlier corn is desired.

Seed was saved from a number of varieties, selections being made for the earliest as in the preceding year. It was evident that some of the varieties were worth improving for growing in this locality, though at the same time the search for varieties better adapted should be continued.

Of the fourteen varieties tested in co-operation with the Department of Agriculture, seven were dent varieties and seven were flint varieties. Five were from North Dakota, three dents and two flints; four were from Minnesota, three dents and one flint; one dent was from Michigan; and the remaining four flint varieties were from South Dakota, Massachusetts, Connecticut, and Rhode Island. Judging from a single year's test, the varieties from North Dakota are the best adapted to the conditions at Moscow, one of the dents and two of the flints maturing seed fairly well.

1906.

The lines of work of the two preceding years were continued, and, in addition, the improvement of several promising varieties was begun. In general, the year was more favorable to corn growing than was the previous year, at least after the first of June. A cool, wet spell during the greater part of the latter half of May affected the germination of corn planted before that time. As nearly all of the experiment corn was planted about the middle of May, some of the seed failed to germinate, a comparatively poor stand being the result in some cases.

As to the time of tasseling and silking, there was a wide variation, as in the two years preceding. This variation was almost as great within single varieties as among the different varieties. The earliest variety began to tassel *July 16th*; the latest, *July 31st*. The first silk appeared *July 23rd*, and the latest variety began to silk *August 12th*. The situation of the earliest tasseling variety, however, was a little more favorable in respect to the warming up of the soil, which may account for several days of the variation.

The testing of varieties in cooperation with the Department of Agriculture was continued. Thirteen varieties, only, were sent this year, one of the dents from Minnesota being omitted. The results were much the same as those of the preceding year, the same varieties as in that year giving the best results.

Breeding work was begun with fifteen varieties of corn, eight dents and seven flints. All of the dents were yellow varieties. Six of these were Idaho grown, and were un-named; and as there were no great differences, it is very probable that they were not six distinct varieties. The variety that seemed the most promising was planted the most extensively, individual ears being planted by the row system. One-half of each row was detasseled, the one-half of one row and the opposite half of the next row, to prevent too close in-breeding. At intervals within this variety, rows of six other varieties were planted, and of these the entire rows were detasseled, thus providing for their pollination by the first-mentioned variety. Notes were kept on the development of the different varieties and the earliest ears were marked in the field as seed ears. A quantity of very good seed corn was saved from this experiment, and it is expected that a very satisfactory variety will be developed from the seed saved. Where the stand was good, the best of the corn yielded at the rate of about forty bushels per acre, although much of it was very immature at the time of the first heavy frost.

The above experiment was repeated, another variety being used as the pollinating variety. Two experiments of the same character were laid out for the flint varieties. The seed selected in these three experiments was injured in the field by heavy fall rains, and was practically lost.

Nine varieties of sweet corn and three varieties of pop corn were tested for earliness, being planted May 15th. Three of the sweet corns were fairly satisfactory. They began to tassel the same day, *July 17th*. One of them, the Peep O'Day, began to silk *July 22nd* and the other two began to silk *July 25th*. Only one of the pop corns was early enough to be of any use. It began to tassel *July 17th* and to silk *July 31st*. It was an un-named variety grown near Moscow.

The above short account of the corn work begun at the Experiment Station, gives a general idea of the pioneer work necessary in determining the variety of corn best adapted to an unfavorable climate. With the seed now on hand, the building up of a variety well adapted to the conditions at Moscow is simply a matter of a few years' selection.

VARIETIES OF CORN TESTED AT MOSCOW.

No.	Variety or Strain	Type§	1905 Days from planting to first Tassels	1905 Days from planting to first Silks	1906 Days from planting to first Tassels	1906 Days from planting to first Silks	Ave. height in inches	Stage on Maturity Sept. 5, 1905.	Stage on Maturity Sept. 11, 1906
1	J. O. Hill*	W. D.	53	63			55	Medium dent	
2	T. G. Dowdy*	Y. D.	59	68			67	Late milk	
3	L. K. Strong*	Y. D.	61	68	67	74	62	Late milk	
4	Andrew Wilson*	R. D.	61	74			60	Early milk	
5	R. S. Matthews*	Y. D.	67	84			62	Shooting	
6	Golden Surprise	Y. D.	68	83			64	Late pollinat'n	
7	Butterfield & Elder*†	Y. D.	61	71			60	Medium milk	
8	A. L. Hinkley*	Y. D.	61	69			60	Late milk	
9	Leaming	Y. D.	71				68	No ears	
10	L. H. Ayers*†	Y. D.	56	66			64	Early dent	
11	L. H. Ayers*	Y. D.	61	73			62	Late Milk	
12	Minnesota King	Y. D.	61	71	77	83	65	Late pollinat'n	Late roasting ear
13	Minnesota No. 13	Y. D.	61	70	72	86	72	Medium milk	Late roasting ear
14	Strawberry Dent	R. D.	61	70			58	Medium milk	
15	Northwest Dent	R. D.	59	71			60	Medium milk	
16	L. H. Ayers.	W. D.	56	66			62	Late milk	

VARIETIES OF CORN TESTED AT MOSCOW.

No.	Variety or Strain	Type§	1905		1906		Ave. height in inches	Stage on Maturity	
			Days from planting to first					Sept. 5, 1905.	Sept. 11, 1906
			Tassels	Silks	Tassels	Silks			
17	Mercer	Y. F.	64	75			58	Early dent	
18	Smut Nose	Y. F.	61	71			62	Late dent	
19	Sterling	Y. F.	67	83			68	Late pollinat'n	
20	Golden Ideal	R. F.	67	78	73	88	72	Late pollinat'n	Late roasting ear
21	Dakota Sunshine	R. F.	64	71	67	79	62	Medium milk	Early dent
22	N. D. Golden Dent	R. F.	59	66	67	75	60	Early dent	Medium dent
23	Northwest Dent	R. D.	53	68	68	82	58	Late milk	Medium dent
24	Rustler	W. D.	61	75	73	83	70	Early milk	Roasting ear
25	Early Tuscorora	W. F.	55	68	63	73	54	Medium milk	Late roasting ear
26	N. D. White Flint	W. F.	53	63	63	71	45	Late Milk	Medium flint
27	Gehn	Y. F.	58	63	63	75	46	Medium glaze	Hard flint
28	Moore's Premium	Y. F.	53	66	72	86	54	Late glaze	Late roasting ear
29	Triumph	Y. F.	64	78	73	87	60	Early milk	Early flint
30	90-Day Flint	R. F.	66	88	70	89	58	Early milk	Medium roasting ear
31	R. I. White Flint	W. F.	56	63	63	81	56	Medium milk	Late roasting ear
32	King Philip	R. F.	61	70			54	Medium milk	

VARIETIES OF CORN TESTED AT MOSCOW.

No.	Variety or Strain	Type?	1905 Days from planting to first Tassels	1905 Days from planting to first Silks	1906 Days from planting to first Tassels	1906 Days from planting to first Silks	Ave. height in inches	Stage on Maturity Sept. 5, 1905.	Stage on Maturity Sept. 11, 1906.
33	Smut Nose	Y. F.	61	73			68	Medium milk	
34	Mercer	Y. F.	59	70			65	Early glaze	
35	Triumph	Y. F.	61	73			64	Medium milk	
36	Longfellow	Y. F.	61	75			60	Early milk	
37	Early Northwestern	R. D.	53	65	74	86	64	Early glaze	Late roasting ear
33	Strawberry Dent	R. D.	61	71			74	Medium milk	
39	Iowa Silver Mine	W. D.	67	80			72	Late pollinat'n	
40	Sterling	W. D.	61	72			80	Medium milk	
41	Rustler	W. D.	61	72			70	Medium milk	
42	Minnesota King	Y. D.	59	68			64	Medium milk	
43	Mastodan	Y. D.	71	80			78	Late pollinat-n	
44	Min. Yellow Dent	Y. D.	59	70			80	Medium milk	
45	Gold Medal	Y. D.	59	69			80	Late milk	
46	Dakota Dent	Y. D.	61	70	77	88	78	Medium milk	Late roasting ear
47	Iowa Gold Mine	Y. D.	66	83			90	Very early	
43	Golden Harvest	Y. D.	64	75			76	A few shoots	

VARIETIES OF CORN TESTED AT MOSCOW.

No.	Variety or Strain	Type§	1905 Days from planting to first Tassels	1905 Days from planting to first Silks	1906 Days from planting to first Tassels	1906 Days from planting to first Silks	Ave. height in inches	Stage on Maturity Sept. 5, 1905.	Stage on Maturity Sept. 11, 1906.
49	Huron	Y. D.	59	66			80	Medium milk	
50	White Cap	Y. D.	56	64	74	82	78	Medium milk	Early dent
51	A. L. Hinckley*†	Y. D.	59	63			72	Late milk	
52	L. H. Ayers*†	Y. D.	53	63			76	Early dent	
53	L. H. Ayers*†	Y. D.	53	65			70	Late dent	
54	Pride of the North	Y. D.			84				Watery
55	S. W. Bigham*	Y. D.			67	78			
56	J. S. Hogue*	Y. D.			67	79			Medium Dent.
57	P. H. Teare*	Y. D.			67	80			Medium Dent
58	James Fogle*‡	Y. D.			64	72			
59	Black Mexican	Sweet	64	73	71	90			
60	Early Mammoth Cory	Sweet			80	91			
62	Peep O'Day	Sweet			63	68			
63	Golden West	Sweet			68	85			
64	Early Minnesota	Sweet			66	77			
65	Frank Gustafson*	Sweet			63	71			

VARIETIES OF CORN TESTED AT MOSCOW.

No.	Variety or Strain	Type§	1905 Days from planting to first		1906 Days from planting to first		Ave. height in inches	Stage on Maturity	
			Tassels	Silks	Tassels	Silks		Sept. 5, 1905.	Sept. 11, 1906.
66	L. K. Strong*	Sweet			63	71			
67	Pren Moore*	Sweet			66	79			
68	Pren Moore*	Sweet			78	98			
69	Zig Zag	Sweet	75	83					
70	Pren Moore	Pop			72	83			
71	O. C. Carssow*	Pop			63	77			
72	White Rice	Pop			79	85			
73	Arthur Pence*	Pop	68	85					
74	Primitive	Pod	68	85					

§ D-dent; F-flint; W-white; Y-yellow; R-red.

* Person from whom obtained or by whom grown; variety unknown.

† Seed from early corn selected in 1904.

‡ Planted May 21st, after the cool, wet spell. (See p 53)