METHODS OF CORN BREEDING.

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Our common corn belongs to the tribe Mayadae, and is known botanically as Zea Mays. It has never been found in its wild state, but is generally beleived to be a native of tropical America. It was cultivated by the Indians at the time of America's discovery. Since that time it has been one of the most largely grown of all cereals. The crop of the United States alone being nearly 100,000,000 acres, the average yield being about twenty-five bushels per acre. Fifty to sixty bushels per acre is a very common yield, while seventy-five to one hundred bushels is often obtained. This shows us that some yeilds must be exceedingly low, and if improvement cannot be made on a part of this acreage, it should be used for other purposes.

The value of this great product or cereal is based upon the quantity and quality of grain produced. Anything that will materially increase either one without suffering a decrease in the other will be of great economic importance. Our object should be to secure the largest yields of corn of a high feeding value, at a relatively small cost. As has been shown, there is a large difference in yields per acre, which indicates that some conditions for growing the crop must be much more favorable than others. These conditions are governed by soil, climate, culture and seed, and whenever practical better conditions should be secured and better methods adopted.

First of all, the soil conditions should be favorable, the texture should be right and the required plant nutrients available. We cannot expect a certain field to produce a high yield of the same crop every year, but with special methods of tillage, crop rotation and fertilizing, it should be able to produce crops for an indefinite time.

Climate has its bearing upon crop production; there must be a certain amount of moisture to supply a crop, a season of sufficient length to mature it, and certain conditions of temperature combined with sunshine for the best developement of the crop.

Culture is important. We must provide a proper seed bed in which to plant the seed. The the young plant must have care, protection from weeds must be secured, and the soil kept mellow by cultivation. Proper culture liberates nutrients for plant food and helps to conserve moisture, thereby aiding soil and climate.

The question of proper seed remains yet to be discussed. We must have a corn that is adapted to our climate and conditions. A late maturing crop is not capable of development in a short season, while an early maturing corn cannot make the best use of a longer season. A variety of corn should be developed and bred up in the condition under which it is to be grown.

If the highest yield is to be obtained, a perfect stand of corn must be secured. The distance between the plants in the row may depend largely upon the soil and climatic conditions, but after the proper thickness for planting is once determined for a certain locality or soil, a perfect stand should be sought for, and unless it is obtained fertility and labor which might go to produce grain is lost and the yield per acre decreased.

The question of good seed corn is therefore very important. Germination tests have proven that seed corn taken from an open crib exposed to dampness and freezing is often of low vitality. The germ may not be entirely destroyed, but its vitality may be weakened, and such a kernel cannot produce the same vigorous plant which seed corn of storing vitality is capable of producing. For the best results, seed corn must be quickly and thoroughly dried, and the best methods require artificial drying, after which extreme cold may scarcely effect its vitality. Seed corn may be quickly tested. One of the best methods is to secure a square box or frame, which is divided into small squares. Representative kernels from each ear (usually six kernels) is placed in a differentsquare, their position being noted. Any ear that does not germinate one hundred per cent is to be discarded. Any ear whose vitality seems to be low is to be discarded as such seed is likely to produce less vigorous plants, and if later conditions are unfavorable may fail to produce ears.

If a great number of ears in a field are imperfect, the yield per acre will again be lowered. An ear of corn may be of small circumference or short in length. It may have a poor tip or a poor butt. It may have a shallow kernel or a large space between the rows. The value of an ear of corn is determined by its feeding value or its ability to reproduce itself. We cannot definitely state that an ear that might be described as being perfect will yield more than one of imperfect type, but if of equal composition and of different size the larger of the two is to be desired for feeding purposes, and if each one is able to reproduce itself, the larger one is to be desired for seed. While a selection of considerable value may be made from the ear itself, all the merits of an ear of corn have not been placed upon the score card.

An ear of corn owes its qualities either to heredity or environment. An ear that obtained its good qualities by heredity is more desirable than one that is good from environment. Two ears of equal size and composition may be very different in their possibilities of reproduction. Each ear may be said to have a personality of its own. It has an inherent quality which cannot be measured from the outward appearance. This power or worth can only be estimated in a performance test, and for this we resort to the ear row test.

Some stalks of corn are barren. These stalks are not only of no use, but are occupying the place and using the nourishment that if properly managed might produce a good ear. Any thing, then, that will tend to lessen the number of barren stalks will materially increase our yield. Barren stalks not only do not produce ears themselves, but they produce pollen which helps to fertilize the corn of good producing stalks; thus they tend to propagate the tendency to barrenness in the off-spring.

Some stalks of corn produce suckers. This seems to be a tendency of nature to produce a higher yield, and is espicially noted when the stand of corn is thin. These suckers may produce ears of corn if conditions remain favorable, but if not they are a waste of fertility and a drain on the original stalk of corn. Certain varieties of corn may produce more suckers than others or may have a greater tendency to barrenness. However this characteristic is not wholly inherited as environment plays an important part. Experiments have proven that the thicker a stand of corn may be, the greater the tendency to barrenness, while the thinner the stand, conditions continuing favorable, the greater the number of suckers. While these conditions are partly due to environment, it seems true that the weaker stalks have given away to barrenness and the stronger ones have produced ears.

The method of pollination exerts its influence upon the yield. Nature's method seems to be to cross fertilize, as the pollen is often ripe and begins to fall before the silk of the same plant is ready to recieve it. This may be illustrared by the fact that a stalk of corn grown by itself seldom matures a good ear. Further, pollen is adapted to wind distribution and may be carried for a considerable distance by the wind. Prof. Shamel states in the year book of the department of agriculture, that if corn is self fertilized for two or three generations, the yield is decidedly decreased, other conditions being the same, even the decrease in yield the first year being very marked.

Then in our plan for breeding corn we must secure a good stand, use corn that is adapted to our climate and condition, and conduct our breeding experiments under normal conditions. We should strive to reduce the number of suckers and barren stalks, and adopt such methods as tend to secure cross breeding. Seed from all weaker and inferior stalks should be discarded, and those ears which have been found to be good producers, which have an inherent quality for good that stands high above the average, must be made to propagate themselves.

To secure some of these results the following method is given. First a selection of seed ears is made. As we are not yet sure of the exact form or shape that the ear must be, we cannot say that one type will yield more than another, or whether we should produce one or two ears upon the same stalk. We will make a selection, say of one hundred ears, from the field, of a variety that is adapted to our conditions, which has shown itself to be of greater value than the average corn, and which has had considerable breeding. In making this selection, we should note each ear, also its mother plant, the position of the ear on the plant, etc.

The next step is to plant these ears in the ear row test plot, using only a portion of each ear, the remaining portion to be saved and labeled to be used in the next year's breeding plot if of sufficient value. Rows from ten to fifteen yards long are convenient for the test plot, and are preferable to longer rows unless the soil should be quite uniform. In all breeding work, the testing and careing for seed corn should be observed. To secure a more valuable ear test, a duplicate test is also made; thus two rows are planted from each ear, and yet about one third of each ear is saved for the next year's planting. In the test plot, the conditions for each row should be as near the same as possible, care being taken that the same number of stalks are harvested from each row. The grain is harvested and weighed, and the seed ears from five or ten rows giving the best performance test are saved for planting in the breeding plot of the next year. Now there are two possibilities. First, of the ten highest yielding ears make two breeding plots, using five ears in each plot, taking the highest yielding ear in each plot for the sire ear; that is, using it inevery alternate row, making seven rows in the plot; detasseling all rows but those from the sire ear; thus the performance of both the sire and dam ears are known, each dam ear having been detasseled.

The second case is that each row in the breeding plot represents a different ear. We detassel every other row and of course all inferior and barren stalks. In this case we do not know the exact parent on the sire side, but we do know that nothing but desirable ears have been used, and we have the advantage of having a greater number of families. Either method excludes all close pollination. Seed selections are again made from these detasseled rows, using the type of ears that proved best in the first selection. These ears are all merged and put in the multiplying plot. Only desirable ears from desirable plants find their way into the multiplying plot. In the multiplying plot every other row and all inferior and barren stalks are again detasseled. Seed selection is again made from the detasseled rows as before, for a general field crop. In the general field, only inferior and barren stalks need be detasseled. Larger quantities of seed may now be selected from the field, which should be of a somewhat superior quality. Seed is also selected from the field and multiplying plot on the same year for the next year's ear row test plot. The cycle is complete in four years and no ear ever enters the breeding plot except that it has made a good performance record in the test plot. Each year we have an ear test plot, a breeding plot, a multiplying plot and a general field crop. The ear test plot is made up each year of the preceding year's multiplying plot and general field.

If we would continue this method of breeding without drawing seed from an outside source, the objection of close or line breeding might be raised. But a breeder of pure bred corn may draw on another breeder who has been breeding the same variety of corn in the same manner. Breeders of live stock do this, and corn breeders could do it with less risk, as all outside blood is introduced by way of the ear-row test.

For the ear-row test we have been making an artificial selection each year. This is governed by the size and vigor of the mother plant, size and shape of the ear, including general confirmation. While this selection is artificial, it is based upon a knowledge of the performance of similar ears, since we have taken careful notes on all ears that have gone into the ear test.

So far our discussion has been mainly upon quantity, but certain nutrients of the corn kernel are of more value than others. Corn is rather low in protein, and protein is of greater value than the other constituents; hence a grade of corn with a high per cent of protein may be desirable. The Illinois station has shown that the per cent of protein in corn can be speedily built up, merely by a mechanical selection. The germ and horny matter are relatively high in protein, and a continued selection of ears which are large in these parts will tend to build up this element. It is not known to what extent this selection may be carried on without injuring other qualities. But certainly it should not be carried to excess as protein may be produced quite cheaply in alfalfa. Starch may be a valuable quality; if so, this constituent may be built up in the same manner.

In conclusion, we feel that the amount of corn and feeding value per acre is far more important than the fancy points which may be considered. While an ear of corn is in itself beautiful, its true value is determined by its feeding value. For feeding value it makes little difference whether an ear has straight rows, a peculiar indentation, or a certain type; but a hgih yield and a perfect ear have not been found to be in opposition, and our performance test tends to draw out or develop a special or uniform type. The ear that yields the highest in the ear test must be of a sufficient size, length and circumference, must have kernels of a certain depth, and must be well filled at the butt and tip. When we have a strain of corn that has been bred pure for a number of generations, and has been required to make a certain performance test, it tends to become of a uniform type, and from the law that like begets like, we may expect the off-spring of such a strain to be of a superior quality.

Plans for Breeding.

Ist. year. Select ears from field.			
2nd. year. Ear test. IOO rows. IO rods long and duplicate.			
3rd. year. Breeding plot. I2 best ears.	Ear test.		
4th. year. Multiplying plot.	Breeding plot.	Ear test.	
5th. year. Field.	Multiplying plot.	Breeding plot.	Ear test.
6th. year. Ear test.	Field.	Multiplying plot.	Breeding plot.
7th. year. Breeding plot.	Ear test.	Field.	Multiplying plot.
8th. year Multiplying plot.	Breeding plot.	Ear test.	Field.
9th. year. Field.	Multiplying plot.	Breeding plot.	Ear test.