

BREEDING AGRICULTURAL PLANTS.

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BREEDING AGRICULTURAL PLANTS.

It pays to have the best; disregarding mere appearances and looking at it altogether from the commercial side -- it pays. Our cattle, our vegetable garden and our flowering plants are all the product of breeding with its consequent care and attention.

BREEDING AND ITS RESULTS.

It has been but a few years since our cattle were all of the long narrow type; poor feeders, slow of growth, small at the finish, making inferior meat and not markedly prolific. Now we find well bred cattle here; they out-weigh and out-sell the range cattle, are better feeders, early maturing and prolific. Care and selection, adaptation to a specific use and familiarity with the climate have brought about these things, giving us an increase in quality and in quantity at the same time. It is thus with few exceptions in the case of all animals.

Among plants we find the pansy, the aster, the violet and many more of our well known flowering plants have been more than doubled in size and quadrupled in beauty within recent years and this too, and this too accompanied by a greater range of growth. The plants of the vegetable garden suffer many changes, some running out, others being displaced, but always changing, because we set an ideal by our desires, and a more prolific article or a product of fine quality is always sought. Since the gardner at the most must be governed largely by the amount of profit the given variety will yield him he uses the desirable and soon the neglected varieties are out of date, the seed man ceases to grow

them and they disappear. The seedsman must supply the demand for seed by caring for and selecting good pure seeds; he must also be on the alert for new plants or by cross breeding he must produce create new varieties; then by years of careful selection he must prepare the new varieties for the market.

THE DEMAND FOR WELL BRED PLANTS.

Whether considered from the view point of the farmer or the commercial seed grower as the word breeding is here used it comprises not only cross breeding and hybridization but also the production of seed for further seed production. It means the growing and careful selecting of seed for certain purposes. We need seed adapted to all localities and climates; seed from healthy, prolific plants; seed that is true to name, that will germinate and grow, maturing at known periods; seed rich in protein, starch, oil, or gluten, seed producing plants especially valuable for pasturage or hay; and in fact, the range of possibilities before the breeder is so great that he must be very careful in considering the exact ideal he means to strive for, therefore, let us look at the things that will have a bearing on his work.

THE SEED AS AFFECTED BY CLIMATE, SOIL AND CULTURE.

The belief that a change of seed from one locality to another especially from north to south, will give a larger yielding progeny is so well established in common practice that experimental proof seems needless. French investigations show that northern grown seed produces the most grain. Some of our experiment stations have conducted investigations on this subject re-

reporting similar results and in the mere change from Maine to New York the Maine seed is seen to be more prolific. Now this would appear to prove that the common belief is well founded. It is quite well known that northern grown seeds, on account of the shorter seasons where they have been grown, produce quickly maturing plants, and plants as a rule of more resistance to cold. Introduced into a lower latitude they will be satisfactory for a single crop, but their tendency to deteriorate and "run out" is so great, that the imported seed must constantly be used for sowing. The attempt of the plant to become adapted to the new climate gives rise to numberless variations, some of which if found and cared for, may be even better than the original itself.

Soil has a great influence upon plants and their seed. As we ordinarily think of soil it is a mass of plant food ready for the use of the growing plant. Bailey says, "The greater part of the changes in the physical conditions of life hinge upon the relative supply of food. The entire practice of agriculture is built upon the augmentation of food supply. For this purpose we set plants in isolated positions, we till the ground, keep down other plants or weeds, add plant food to the soil, prune the trees, and thin the fruit." We can render more food accessible by aiding in increasing its solubility; otherwise it is inavailable to plants.

Intensive cultivation, the application of fertilizers, the draining off of excess of water and the conservation of moisture are the most available means of increasing the food supply. Plants from the same seed will exhibit differences in yield, in seed,

and forage value, on dissimilar soils when other conditions are similar. The soil seems to have an effect, and when the seed is planted on different soils the inherited characteristics of the seed may be so far from adapted to the conditions that the resulting plant will be very undesirable, or on the contrary the plant may be so exactly suited to the nature of the soil from which it draws its nourishment as to make an exceptionally perfect individual, and thus in selecting a plant from which to choose seed, we would prefer the one manifestly adapted to its environment. It is not always the most fertile soils which are able to produce the most desirable seed or crops. Experiments have demonstrated, for instance, that grains grown first on light soils did best when planted on similar soils, giving a light crop when on heavy soils; but after becoming adapted to this heavy soil seed did best on heavy soil when compared with a crop from the same seed on light soil. We may conclude from the above, that while seed will become adapted to a soil, yet if it is an agricultural crop that is desired, only a small portion of which will be used for seed, then it is best to use seed adapted to the conditions of the soil, thus necessitating that the farmer grow his own seed or obtain it from plants grown under similar conditions to those existing on his farm.

THE PLANT AND ITS SELECTION ; THE INDIVIDUAL AND THE IDEAL.

No two plants are exactly alike. We do not recognize this at first but we can by careful observation find differences between any two plants. (Everything in Nature is dependent upon

conditions for its growth and two seeds from the same plant may produce quite dissimilar plants.) The length of time before the flower was fertilized, the strength of the pollen that produced the fertilizing stimulus, and a great many other possibilities intervene to give one seed an advantage over the other. Then the soil is so irregular in composition that one plant is sure to be fed differently from its neighbor. Beneath it the ground may be too compact, too full of undecayed vegetable matter, or already crowded with the feeders of other plants. The shading caused by a neighbor or the influence of a few weeds may so cripple the plant as to give another seed from the same plant an opportunity to produce in its growth a much superior individual. It is the individual plant that we must consider very carefully. Two grains of corn may look alike, weigh alike and by every test seem the same although we cannot tell which came from a plant having three ears and which came from the only ear produced, and yet, all things being equal one ought to give double the yield the other gives. With ordinary methods in selecting seed wheat we avoid light, shrunken kernels, but should we not also take into account the yield, the number of side shoots thrown up by the plant, the size and strength of the straw, the efficiency of the root system, the resistance to cold and drouth and winds, the force that repels disease and protects from insects? We are too apt to look for a good, plump seed, large and heavy and it is imprative, too, for the best success, but no two plants are alike. It is the individual plant first, the seed later. Nature deals with

individuals alone, and each single plant grows to fit its allotted space, filling its little sphere as best it can under the conditions with which it has to contend. Each individual tends to become still ~~far~~ more unlike even the others from the same parent plant as the environments of the different single plants are unlike. More than this there are other things to be considered which bear directly upon the qualities of the wheat enumerated above. Plants are so constituted that they may be largely lacking in one thing and yet be in a fair state of repair, so in selecting our ideal plant we should as far as possible be sure that it is a perfect plant. We may find one that lacks only a little, and improve it by care or by crossing it with a desirable individual having that characteristic, with the assurance that we will obtain the result after a few years of selection and regular culture.

THE SEED AND ITS SELECTION.

Having considered the plant the next thing is the part of the plant from which the seed is to come. While experiments go to show a difference as regards the value of seed from different parts of plants they are of such a nature that no absolute conclusion can be drawn from them. The inference, however, from the available data is that the lower flowers on the stalk or the main stalk of a group furnish the best seed, this is probably owing to the greater size and weight of the seed.

VITALITY:— The degree of maturity of seed when gathered is an important factor in determining its value. Advantage is often taken of the fact that immature seeds yield an earlier and more numerous product. While this would be an excellent point

from which to carry on careful selection yet the practice of selling and raising immature seed is to be condemned, since the vitality of the plant and a reduction in the size of both seed and plant is the certain result.

Without a doubt one of the greatest factors in all seed selection is the question of vitality. Seed used for mere grain to be eaten, need have no regard on this score and can be old or neglected to a great extent before its feed value is injured, but when the seed of plants is to be planted we must consider its vitality. The variety makes a difference, also the degree of maturity at the time of harvesting, methods of handling, water content, how stored, how planted, and temperature at which germination takes place. Mature seed should show a high percentage of vitality if carefully handled, dried and stored where the air can have free access to it and planted in fine moist soil that has been allowed to become warm.

Age of seed is quite an important factor in determining the vitality of seeds. Although nothing is definitely known regarding the exact time during which our agricultural seeds retain their vitality yet in general, it decreases as the seed grows older. Some seeds such as ^{those of} cucumbers and melons are supposed to possess a larger percentage of vitality at three years than at the end of the first year. The seeds of some of our common trees lose their vitality very quickly and it seems that our crops decrease in like respect but more slowly; heat, cold, and moisture content being among the foremost agencies at work. A publication by the Office of Experiment Stations, Washington, D. C. has this

to say, "Experiments conducted annually for ten years with wheat, ^{to say} barley and oats showed that the barley and oats retained their vitality very well for that time. The wheat fell off nearly one-half and the rye became practically worthless for seeding purposes." English tests showing a loss ranging from 11% to 100% in less than three years, bring out the fact that from twenty samples ^{of 20} of forage plant seeds which were tested, the last year proved the almost complete loss of vitality for all but alfalfa and white clover which germinated 54 per cent and 22 per cent respectively.

In handling seed one of the first requisites is cleanliness and purity. The presence of dead seed, weed seed, chaff, dirt and trash and also of other seeds used to contaminate the product is one of the surest indices of poor breeding and care. While it is possible for the buyer to partially select his seed from such as this, yet he will not desire to run the risks, and the name of the producer will not be rendered familiar on account of the desirability of his seeds. Seed from ideal plants under proper conditions of soil and climate, well cleaned and stored, require at least three more selections before they can be said to have received the required amount of care.

WEIGHT:-- Experiments show almost without exception that the largest and heaviest seed tend to produce the largest and most vigorous plants. The lighter seed may germinate but the seedling is weak, not having the amount of food the other has and it is liable to be greatly affected by any sudden change in the weather conditions. Seed may show a high test for germinability ^{But} not be able to withstand the actual field conditions and so

fail to sprout a good stand. A German experiment has shown that from a given sized sample the number of seed producing plants increased with the increased weight of the individual seeds. The U. S. Department of Agriculture is authority for the statement that large heavy seeds showed a manifest superiority over smaller light ones in tests with radishes, amber cane, Kafir corn, barley, oats, sweet peas, winter vetch and rye; no other seeds were tried. The manner of securing large and heavy seeds is perhaps best accomplished by means of wind power or a centrifugal apparatus in which cases the seed is quite uniformly graded.

The selection of seed with regard to its shape, size, color, chemical contents and general appearance must be done by hand and requires great care to be successful. Here the final conclusion is drawn as to the work of tillage, cross breeding and selection. The seeds are required to be of a good clear, bright color, without indication of poor storage or impurities and they must conform to the standard of size and shape desired.

GERMINATION TESTS:-- Seeds even though they may be known to be of a high percentage of vitality should nevertheless be tested before planting. Average samples of each lot of seed should be taken, and from the percentage of germination the amount of seed required per acre can be calculated, the condition of the field being known.

COMMERCIAL SEED PRODUCTION OR BREEDING.

The condition of the soil and the demands of the different crops are so various that mention of the tillage and care of

of the common agricultural crops is impossible here. However, the man who grows plants for the grain, can be left out of the question -- he can purchase his seed each year. The man growing grain but who prefers to select his own seed or he who is a commercial seed producer should have separate plots for its production. Here year after year he should grow his finest seed and use its products in planting his main crop the next year, but the very finest of its yield should go into the seed plot again and the process should be continued as in the case of pure bred animals. As in the case of animals also new blood may be needed; so selection may be carried on in a large field also. Seed so selected when planted in the breeding plot will spread its pollen around easily and being of the same strain no evil effects will follow. The introduction of pollen from another strain may cause large variation and the loss of many years work.

Among the most important adjuncts of selection to be practiced is the culling out of sterile and poorly yielding plants, for these being fertilized by the others yield seeds which may be of quite an inferior quality. The cutting out of such plants and the removal of undesirable types and forms is very important. The careful suppression of disease and the proper rotation of the crop to new fields in order to prevent the results both to the plants and to the land due to long cropping will be found of great assistance in increasing the hardiness and vigor of the plants.

There is a form of breeding which is practiced with good results where a single crop is desired and no regard to seed is needed. It consists in crossing in the fields two strains or varieties of the crop. This is accomplished by planting a given

seed as the main crop but having also rows of the other kind at intervals through the field. In this manner a natural crossing takes place and the stimulating effect results in a larger and heavier yield of grain. This has been practiced year after year, two pure bred strains being maintained for the purpose.

HYBRIDIZATION OR CROSS FERTILIZATION.

The subject of hybridization and cross fertilizing, which is as indicated previously a part of the subject, is one of great importance. The establishment of strains of certain plants will lead to the final securing of "pure bred seed", but the agriculturists find that the demand of the consumer and of the environment in certain localities are such that no known variety is ideal for the place. He then resorts to crossing. The aim is to secure a new plant of known characteristics.

The result of the crossings should be fixed in the breeder's mind as an ideal to be secured and in choosing this ideal he should avoid striving after characteristics that are antagonistic or too far removed from the plants dealt with. The aim of the crossing is to induce variation with the hope that it may bring forth the something along the desired line. Plants possessing the desired qualities, in part in each, are crossed and their offspring are sown and watched. Some will seem unchanged; some like one or the other parent, some entirely dissimilar. In the succeeding generations, especially the second, the breeder must rigidly suppress some forms and suppress others and by continued selection with, if need be, more crossing, plants are secured coming near the

ideal. These are now planted largely and the most desirable hunted out to be bred from. Usually in from seven to ten years the variation becomes reduced to the normal and a plant has been secured closely resembling the ideal.

The breeder who has a clear enough insight into the results that may arise from crossing or from hybridizing plants and who has been engaged in the culture of agricultural plants for a long enough time to have a definite ideal in mind can well afford to take up the work of artificially cross fertilizing varieties or species in plants. His object being a definite ideal he can select varieties possessing in the main these required points and by doing all the work by hand be sure of his result.

Cereals are usually planted by the cross breeder, in pots or in small beds and then transplanted to the field, or in some case left in the pots. The plants are set very carefully and systematically in ground that has been prepared with much pains and with great uniformity. If it be a winter growing plant there is then abundant opportunity to observe its resistance to cold, freezing, heaving of the ground, drying winds and lack of moisture. In all plants the manner of sending up side shoots, the amount of foliage, the number and size of seed stalks, and the general health of the plant, all of which are of the utmost importance, are easily observed when the plants are thus separated. All plants not desirable are cut down or at least prevented from producing pollen (de-tassellingⁱⁿ the case of corn). This is to remove any chance of the undesirable pollen finding and fertilizing a desirable female flower.

When ready for crossing the workman removes all but the best shoots, spikelets, or ears on the plant which, however, is a questionable practice, since all the seed buds originally produced should be fed by the plant in order to fully develop its power of bearing a large quantity of seed-- a flower selected as the female is now opened and the stamens removed by a pair of forceps or a needle. The pollen, obtained by a clean wet brush from the plant chosen as the male is now carefully placed in position on the stigmas of the female flower, the natural covering if any is replaced, and a sack labled with the name and the date of the cross is placed over the flower to keep it free from natural pollination. The operation may be repeated two or three times at intervals of a day or so, all this manipulation being necessitated by the fact that the cross pollination and removal of the stamens on the female plant must be done just before the plant comes in bloom in order to prevent self-fertilization or the possibility of outside pollen reaching the plant before the operation is performed.

By means of these cross pollinated plants a few seeds are at first obtained. They must not be regarded as of any importance or any great immediate value except as far as their inherited characteristics and the great amount of variation caused by the cross pollination which should be contained in them is concerned. It is only by years of careful planting, selection, and care, with perhaps the crossing of some of the plants thus obtained, among themselves, that anything desirable can be hoped for; once something approaching the ideal is found, however, it should be closely watched and carefully multiplied, all deviations from the ideal being suppressed and all favorable characteristics being

encouraged and perpetuated until the plant or the strain that is now the product of the first plant is fixed, i. e. until it becomes true from seed and the tendency to vary which was induced by the first crossing is eliminated.

CONCLUSION.

Agricultural seed breeding is a field but recently entered from a scientific and a business basis, and in the few years that it has been prosecuted by trained men it has given ample proof that it is full of great possibilities. The work at the Minnesota Experiment Station on wheat; the work at the Illinois Station on corn, which has been almost wholly by culture and selection alone, the work by farmers and scientists in Europe and the work now being carried on here at Manhattan shows that as a rule time is needed, that perhaps many years seem necessary, but that when at last the results come they are sure to reward the laborer.