MAIZE SELECTION AT THE IMPERIAL COLLEGE, TRINIDAD
1928 - 29.

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INTRODUCTION

Maize is a crop the merits of which, as a food for man and beast, have been extolled so often that it would be superfluous to recapitulate them here. It played a very important part in the old Maya civilisation, its use being closely bound up with both their religious rites and their social customs. The original home of this plant and its parent forms are obscure but probably Central America was the seat of its first cultivation; though at least one writer suggests that it was being grown in Asia before Columbus had discovered the New World.

From Central America maize was gradually carried to the northern continent where its cultivation, chiefly by the women, provided a welcome reserve to supplement game or to make up for its scarcity.

Whatever the date of its introduction into these islands, it is certain that the Spanish discoverers of America found maize extensively used as food by the Caribes, and other inhabitants of the West Indies.

At the present time maize cannot be observed growing in any large areas in Trinidad but it is chiefly grown in small patches in natives' gardens. It is thus difficult to assess the amount of the crop which is grown in the island. The indigenous stocks appear to be hardy and fairly resistant to insect and fungal attacks; but genetically there are a great number of types mingled in a field sample differing both in yielding capacity, ear character and vigour. Whether the production of a fairly pure type of seed of higher yielding power would be rendering to Trinidad a benefit of any measurable
measurable dimensions and whether this seed could be distributed to native cultivators and its higher standard maintained is a problem for the economist rather than for the plant breeder.

It may be of interest if the figures relating to the import of maize into the island are quoted: (2)

In 1927, 1,514,192 lb. of maize were imported for home consumption. Over a million pounds of this came from Venezuela and nearly half a million pounds from the Argentine. The total value was only £6,041. In addition, 5,399 bags of 196 lb. of corn meal were imported, (4,809 bags from the United States) to the value of £6,037.

The exports of the domestic produce were only 205,300 lb., valued at £985, 152,458 lb. of which were destined for the British West Indies, 46,592 lb. for the French West Indies, and 6,250 for British Guiana.

At the same time 285,788 lb. of wheat meal to the value of £426,198 and 27,919,886 lb. of rice, costing the island £202,908 were imported, the two imports together totalling £629,006 out of a total import of goods into Trinidad valued at £5,082,871.

The figures are striking. As was pointed out by Bruce and Savile, working at the College last year, (3) maize will grow admirably well in this island. There is surely a strong possibility that properly cooked nutritious corn, corn meal and corn products, consumed largely in America, might take a more important part in the dietetics of the island, nor should their value in cattle feeding be forgotten.

The small island of Tobago exports some maize, though the yields are only about twenty bushels per acre, since it is grown in mixed cultivation. St. Vincent exports maize to Barbados and other islands and the peasant production is stimulated by the organisation brought into being by the Government to buy up, store and sell the grain.
The price of maize on the world's markets has been observed to be steadily approaching the price of wheat. Before the war maize was only realising about half the price of the great grain of the temperate regions. Europe is taking an increasing amount of maize. The United States produces roughly two-thirds of the world's supply; but only about one per cent of the American crop is exported as maize as it is preferred to turn it into stock products. Thus it is even possible that as well as fulfilling local needs an export trade might be built up by means of which maize from Trinidad might compete on the markets of the world.

The object of the work to be described and discussed in this thesis was the production of a better strain of maize, both in regard to superior yielding ability and greater vigour and resistance to disease. In this connection reference may be made to a writer of more than thirty years ago (1) who stated that "in the West Indies the common eight-rowed yellow corn is the hardest and best for general cultivation; but", he added, "unfortunately, owing to bad cultivation and carelessness in the selection of seed, this kind has deteriorated in many of the islands". We found no cobs, during our examination of many scores, with as few as eight rows and even ten rowed cobs were in the minority.

It will be noticed that the title of this thesis has been changed from that of the work done with similar aims by our predecessors. During our researches into the literature upon maize improvement we perceived that the "Ear to Row" method of maize selection no longer holds first place in the favour of American workers; and though the American agricultural investigators may perhaps not see the farmers' wood for their own scientific trees, not to mention the innumerable genetical branches and leafy twigs, they are undoubtedly in the van in promoting the world's progress in knowledge of the corn crop. However, we did not entirely abandon the
the former method of maize breeding, and while prudently sacrificing to the old gods we made oblations to the new.

Not only did we alter the scheme of work in connection with this problem in accordance with newer ideas, but we also abandoned certain points of selection adopted by our predecessors, and as to the importance of which we disagreed: these points will be explained fully in later sections of this paper and our reasons set forth.

The worker on maize soon realises the difficulties entailed by the fact that maize is naturally a cross pollinated plant which makes selection a far more difficult thing than when dealing with a kind of plant which when selected for certain desirable characteristics may be relied upon to reproduce faithful copies of itself. As will be explained in the following discussion of previous work, the breeding and crossing of self-fertilised lines is the method of attack which is recommended, but this means that much laborious and painstaking work must be done before results are visible, after seven years or more. Nevertheless, it is suggested that at such an institution as the Imperial College the policy of experimentation should not be dictated by the specious claims of expediency, and that the work concerning maize should be laid down on the soundest foundation possible and in accordance with the trend of modern theories of maize breeding.
PART A. LITERATURE

I. Ear Type in Seed Selection.

It is probable that the selection of the larger and better looking ears was employed very early in the history of the cultivation of the maize plant as a means of improving the crop. Eventually there evolved the elaborate show-card system of the American breeders, who competed with one another at the Corn Shows for the award of the palm for the most symmetrical and uniform cobs. Though this system played a great part in the elimination of poor types and in the raising of the general standard of the corn crop, it is now generally felt that breeding for "aesthetic" qualities which may have no bearing upon productiveness should now be abandoned and yield concentrated upon.

Hartley quoted by Morgan (4) said that "No visible characters of apparently good seed ears are indicative of high yielding power"; and this view has been endorsed by many writers since then.

Experiments were carried out in Mauritius from 1916 - 1920 on the selection of Yellow Flint maize, and the writer of the bulletin (5) in which the work is described spoke of selection for an increase in size of ear borne by each plant as one of the methods which suggest themselves for improving the yield. Investigations were made as to the effect of the number of rows of grain per cob, and an interesting observation was that the progeny of a cob with a certain number of rows vary in row number among themselves and differ from the parent. The weights of the cobs were found to increase with the number of rows and the results obtained in Mauritius indicated that "ears possessing 12 rows of grain give so small a return both per ear and per acre that they may safely be discarded in future trials, and there are also indications that the same
conclusion may be reached in the case of 14-rowed strains". It was noted in this connection that a low number of rows is by no means invariably a disadvantage. The type of dentz maize which appears to thrive best under diverse conditions in the Union of South Africa is an 8-rowed breed (Hickory King), this breed being apparently hardy and robust. The question is bound up to some extent with the size of the grain, the Hickory King being a very large-grained type while the local high-rowed strains are usually small grained. The interesting question is at once raised as to whether on poor soil with a low rainfall better results might not be obtained with a few rowed breed; since, under such conditions, the grains on a high rowed ear would be extremely small.

The writer goes on to remark that in well cultivated soil, and with favourable weather conditions, the ears of a high rowed large seeded breed would be able to attain their maximum length and could be profitably grown. It may be said here, in parenthesis, that as far as our observation went, during this year at St. Augustine, the high rowed cobs generally were shorter than those with fewer rows, despite the fact that the plants had been growing, presumably, under "favourable weather conditions". However it is true that "diminution in length of ear takes place under adverse conditions as the ear grows from base to the apex, so that in a weakly plant longitudinal growth of the ear is not complete when the life of the plant is ended".

Richey and Willier (1925), after making statistical study of the possible relations between productiveness and some physical characteristics of the seed ears, did not consider that selection from among good seed ears on the basis of ear characters was a desirable method of corn breeding. They pointed out, however, that selecting longer, heavier ears with relatively few rows and wide, thick kernels was desirable as a means of obtaining good seed for general planting.
In 1927 Richay, in discussing the relationship between the physical characters of the ears and yield (6) says that from detailed results taken from a large number of comparisons the heavier ears are preferable from a selection of ears all of which may be suitable for seed and therefore above the average of the variety.

The comparisons also indicate, in general, that ears which long are are heavy because they are likely to be more productive than those which are heavy because of a larger circumference. Finally, he says, the evidence points to ears with heavier cobs, fewer rows, fewer kernels per inch, and a lower shelling percentage and smoother indentation than the old standard short type as being the better yielders. In apparent means of obtaining a greater production of grain per acre: No work was consulted as to the types of corn as the local soft dent type is the heaviest yielder and most suited to the conditions of moisture of Trinidad. Flint types are more adapted to a drier climate. Probably no attempts have been made to introduce the varieties of maize which are used more exclusively for human consumption. Our own experience incidentally tended to confirm that of workers in the Philippines who observed (7) that the softer dent varieties are preferred by the weevils and hence are damaged by them more quickly and completely.

II. Selection of Plant Type.

It is evident that the most vigorous plants with the best development of root and leaf are most likely to produce the best and plumpest cobs.

A fine cob selected from a heap in the store after harvest may be, perhaps, the fortuitous result of favourable soil conditions or the sporadic effort of a plant which is usually average in its productions. On the other hand a good cob which has been chosen from a plant in the field which shows the required growth characters is more likely to be the parent of satisfactory progeny.
Experiments carried on in New South Wales some eight years ago suggested the selection of ears from good hills in the field as a measure contributing to increase of yield. Increases of from five to seven bushels per acre were reported to have accrued from the use of field selected seed as compared with barn selected seed.

As Richey points out, in every case selection should be toward the kind of plant which is adapted best to the conditions under which the corn is to be grown. There are no characters of the corn plant that can be classed as uniformly advantageous from the standpoint of yield, except those indicating the normal vigorous development to which reference was made above.

An apparent means of obtaining a greater production of grain per acre would be the selection of plants which tend to bear more than one cob, thus producing a larger total of grain than the solitary ear of the one-eared type. This possibility was referred to in the Mauritius bulletin mentioned previously, but it was added that little information had been obtained with regard to the advisability of selecting types which bear more than one ear.

However, Richey states that a number of experiments have shown that prolific strains i.e., those having a strong tendency to produce more than one ear per plant under fairly good conditions, are inclined to be more productive than similar strains that normally produce but one ear per plant. The best evidence for this, he says, comes from the Southern States where a long growing season permits larger yields from the individual plants. He points out that the ears are smaller in prolific varieties and at present are difficult to harvest though he suggests they may be developed perhaps with the increasing use of mechanical corn pickers.

Other characters for which plants have been selected are the height of the cobs from the ground, this being related to the facility or otherwise with which they may be picked by hand, and
the angle at which the cob is borne with regard to the stem. Morgan \(^4\) refers to the Illinois experiments, in breeding for high-ear and low-ear types, which demonstrated that the height at which the ear is borne on the plant bears no definite relation to yield, the same conclusion being warranted when the angle of the ear was considered.

Attention was drawn to the fact, nevertheless, that a high borne erect ear is more difficult to harvest and is liable to be inferior as to quality of the grain, as the water is not shed so well from an erect cob as from a drooping ear.

III. Corn Breeding.

It was thought desirable by the writers to treat at some length the previous work on the subject of corn breeding. This determination was brought about by two reasons: by a feeling of the necessity to explain the change in the breeding scheme from that adopted by last year's workers; and with the thought that a short resume of the American work may enable our successors to obtain some understanding of the aims of the work they are undertaking rapidly and at the very commencement of their year, so that the whole programme may proceed smoothly, and without the hitches which might be caused by failure of new workers to appreciate the theories and methods that this work involves.

(a) Mass Selection.

The most primitive method of improvement of the maize crop is known as Mass Selection. This consists in picking out for seed the best ears or the ears from the best plants and repeating the process in following years. This procedure helps to bring the standard of the crop to a certain level, but after several generations no further rapid improvement is seen because, although the worst types are eliminated to some extent, unfavourable genetical factors
factors are not excluded systematically enough. Essentially this is the rough and ready usage of the practical farmer.

(b) Ear-to-Row Method.

The ear-to-row method is a slightly more advanced method of breeding. The seeds from selected ears are planted in separate rows. The best yielding rows are then selected and the best individual plants from these rows. Seed is taken from the selected plants and the process is repeated again next year. It will be observed that no control over the male parent is obtained. A modification of this is the "Remnant Method" by which only half the grain from a selected cob is planted and the remaining halves from cobs which have proved their worth in the field are planted, each in an isolation plot, to breed by themselves.

Rickey admits the probability that the yield of an entirely unselected or unadapted variety could be improved by one or two years of careful ear-to-row selection. He questions however whether the improvement would be sufficiently than that which could be had by mass selection to warrant the extra trouble and expense of the more elaborate method. Certainly there is nothing in the experimental evidence to show that ear-to-row selection is worth while in a variety that is already well adapted. In altering such characteristics as height of ear, height of plant, chemical composition of the kernel, and the like, probably more rapid progress can be made by ear-to-row selection than by mass selection. Such alterations, however, Rickey points out, can be achieved so much more quickly by selection within selfed lines that it is improbable that ear-to-row selection has any real place in present day corn improvement.

A few years earlier Jenholz in New South Wales had shown himself a scientific die-hard by rejecting the method of selection in self-fertilised lines (to be discussed later) in favour
Forgetting that there are "No gains without pains" he criticised the newer scheme because "a large amount of material must be used; at least 100 ears are desirable to start self-fertilised lines. As the grain production cannot be judged until after fertilisation it is necessary to self-pollinate four or five ears in each line, three of which should be grown, making at least 300 lines".

Further he makes a criticism of the technique of a point of self-fertilisation which, if not fool-proof, can with care be made free from the errors he imputes in saying "the use of bags on the silks and tassels does not sufficiently safeguard the introduction of foreign pollen in the field during the act of uncovering the silks".

(c) Line-breeding, Crosses, Synthetic Varieties.

Owing to the fact that maize is almost exclusively cross-pollinated the ordinary commercial strains are of a very complicated genetic mixture; and it was early recognised that vigour in corn is apparently correlated with this heterozygosity. When attempts were made to obtain pure strains by artificial self-fertilisation a great reduction in size was brought about till about the sixth or seventh generation, when the plant, reduced to comparative purity but to a lamentable weakness of growth, reached a fairly constant state. Meanwhile there had been a great loss of progeny plants through the production of sterile plants or plants showing various abnormalities of chlorophyll deficiency, eccentric bisexual tassels or cobs and other forms which either resulted in self annihilation or rendered the plant unfit for the production of useful seed for continued breeding.

Hence it was thought for many years that it was impossible to attain any degree of purity in a commercial maize crop, without sacrificing efficiency and profit, and that the use of seed of very mixed origin, with the accompanying failure to obtain a uniform
uniform product and with the appearance of various abnormal and useless types, was a necessary evil. The term "hybrid vigour" was used glibly to explain away the lack of improvement in the purity of the corn crop. Other plants which are ordinarily cross-pollinated go to seed.

As breeding of corn was carried on more extensively, however, the views of experts changed regarding this question. Rickey (9) said in 1925 "It is recognised that maintaining a high degree of hybridity only prevents the expression of unfavourable recessive factors without eliminating them. The newer methods, therefore, seek to bring these unfavourable factors into expression where they may be recognised and eliminated. This involves selection within self-fertilised lines as the first step."

Later on a review will be made of the work which has been done on hybridisation, but it may be observed here conveniently that a partial purification of the stocks by self-fertilising for some generations, combined with selection, has come to be deemed the essential preliminary if results of any worth are to be obtained. Smith and Brunson had disappointing results in Illinois (10) with varietal crosses but pointed out that their experiments did not deal with "that more complex, the highly promising, plan of corn improvement which involves the production and the subsequent crossing of self-fertilised lines."

Hayes, in an admirable paper published in the Journal of the American Society of Agronomy (11) speaks at some length on the subject of self-fertilised lines. He remarks that it is apparent that certain varieties when self-fertilised produce fewer striking abnormalities than others, and more extensive studies may be necessary for some varieties than for others in order to produce sufficient desirable selfed lines. The question is raised whether the most desirable selfed strains possible have been obtained. Nearly all the selfed strains as yet available in America are inferior to the normal unform product and with the appearance of various abnormal and useless types, was a necessary evil. The term "hybrid vigour" was used glibly to explain away the lack of improvement in the purity of the corn crop. Other plants which are ordinarily cross-pollinated go to seed.
normal commercial varieties: so should energy be devoted to obtaining better selfed strains? The old shibboleth that homozygosity and good yielding ability are incompatible is challenged and examples taken from other plants which are ordinarily cross-pollinated go to strengthen the challenge.

Sunflowers, which were thought to be self-sterile, were found by McRostie (12) to be equal to commercial varieties in vigour after five years selfing. Again, Hayes and Clarke (13) found timothy selfed for three or four years at least as desirable as the commercial types if not more so; while Brewbaker, also at the University Farm, Minnesota, has had good results from the self-fertilisation of rye.

Hayes queries whether there is some physiological or genetic reason why similar results cannot be achieved eventually with corn. It is debatable whether the method by which the problem should be attacked would be by starting large numbers of selfed lines from a single variety, or by the use of fewer numbers, with more careful selection within each original line.

In considering the characters which should be sought for in selfed lines - and this is of the utmost importance - he alludes to the importance of disease resistance, which is a specific character and dependent on hereditary genetic factors.

The obtaining of strains which are resistant to all important diseases is a problem in itself; and the necessity likewise of combining in the same strain other favourable growth factors complicates the problem.

Hayes emphasises that it is undoubted that selfed lines of higher productivity can be obtained, and the cost of the studies will be many times repaid by the commercial uses of improved sorts.

Another point which is of particular moment in regard to Trinidad indigenous maize is that study should be made of the characters in selfed lines which in general are correlated with vigour.
vigour. Various individual characters have been determined, Hayes mentions, at the University Farm, St. Paul, Minnesota, with the hope of learning their relative importance. Correlation coefficients for the relative expression of various characters in different selfed generations have been computed, in order to determine the extent of the inheritance of the characters in question, and are given in a series of tables in this paper under discussion. In general the larger coefficients were obtained for length of ear, size of seed and cob discoloration, also, for some varieties, percentage of smut infection and lodging were rather strongly correlated in the different selfed generations.

The yield of selfed strains is strongly correlated with other characters which are expressions of vigour, such as length of ear, number of ears index, and, to a less degree on the average, with size of seed.

Kyle and Stonenberg found that selfed lines with a fewer number of rows per ear produced relatively longer ears, were freer, from abnormalities, and were more resistant to smut, on the average, than lines which produced more rows of kernels to the ear. Confirmation, or otherwise, of this perhaps may be given during work at the Imperial College, Trinidad.

During experiments at the University Farm, Minnesota, it was noted that in some varieties seedling vigour was strongly correlated with yielding ability, while in other cases there appeared to be no relation between seedling vigour and yield.

In general it was perceived that the only sure criterion of the value of any particular selfed line is the progeny test. Selection must be practised eventually however, and selection in the segregating generations appears well worth while in so far as the characters concerned are the result of genotypic differences.

The length of time for which selfing and selection should be continued before the selfed strain is utilised is a question of considerable
considerable import. Complete homozygosis would be the ideal aim, providing sufficient vigour could be retained; but practically it may be necessary to self only until the strain appears relatively uniform and free from striking abnormalities. Lines would be expected to be very In a bulletin published eighteen months ago, and to which reference has already been made Richay defines selection within self-fertilised lines as consisting essentially in (1) the isolation by self-fertilisation and the selection of lines that breed true, more or less, for certain characters; (2) the determination of which lines are more productive; and (3) the utilisation of such selfed lines commercially in various ways. Abnormal ity it was soon thought desirable to control. In practice, he explains, a number of desirable plants are self-pollinated. The seed from the better plants is planted, an ear to a row. Self-pollination is then carried out among the progeny plants, from among which selection is continued in the same way. After the various lines begin to breed relatively true, crosses are made between them and compared for productiveness. The lines that produce the higher yielding and more desirable crosses are used as will be explained in later paragraphs. The rigorous nature of the selection necessary among plants in the selfed lines is insisted upon, and it is remarked that only the best kernels on the ears from the best plants in the best individual rows of one season's crop should be used for the breeding stock of the following year. The abnormal plant types which are liable to occur, e.g., plants exhibiting some form of chlorophyll deficiency, sterile or eccentric inflorescences, etc., are to be eliminated promptly from the breeding stock. It is admitted that the task of positive plant selection is more difficult. No more guidance is given to the perplexed breeder than is contained in the dictum that "in general the more productive plants which are healthy and well adapted to the conditions
conditions of growth under which they are needed to live are chosen".

Rickey states that the yields obtained from selfed lines are of little interest at present. Nevertheless he adds the comforting assurance that the proportion of superior lines would be expected to be very small and that the failure to obtain any of these up to the present is of little import. Later experiments are encouraging, he says, in that much better selfed lines are being obtained under the more extensive selection now being practised.

We have referred to the fact that attention was drawn early to the correlation of heterozygosity and vigour. As a natural sequence with regard to this phenomenon it was soon thought desirable to control the hybridity, as it were, by crossing artificially two or more lines containing many good factors; and not to let the heterozygosis be the chance result of wind pollination among types which are perhaps in many ways unsuitable.

As long ago as 1910, Dr. Shull emphasised the value of isolating pure lines and using the first generation (or F₁) crosses for maximum production.

The whole aspect of corn breeding was changed, and general support was obtained for all modern methods, by the work of Dr. D. F. Jones and others who placed the effects of crossing and selfing on a definite genetic basis. Dr. Jones (15) proposed the hypothesis that the vigour of the first generation cross is the result of the interaction of dominant favourable growth factors some of which are supplied by each of the parent lines. In order to explain why no selfed line was as vigorous as the normal variety, it was further supposed as a result of linkage that it was very difficult to obtain all desirable growth factors in one homozygous line.

It has been realised that the limit of progress by the older methods has been reached in the majority of cases. There has been led
likewise a growing appreciation that with adapted varieties close selection to score-card type, if carefully continued may lead, and has led, to a reduction in yielding ability.\(^{(11)}\)

In discussing the single cross, that is the cross of two selfed strains, Hayes notes a difficulty liable to arise in that the low yield of seed from closely inbred lines will result in the increased cost of seed production. Again the seed of inbred lines is often smaller than that of the commercial varieties, and this is a handicap for the young plant when single crosses are used for the commercial crop. As Hayes remarks, when better selfed strains are obtained the single cross plan may be more feasible.

Another way of utilizing selfed strands is in the "double cross". This is the first generation cross between two single selfcrosses, so four strains may be blended in this plant. The variability of individual plants of a double cross will be greater than in a single cross; but this may be advantageous in that the prolonged period of pollination may be a boon to the crop under certain environmental conditions.

Experiments in Connecticut, from 1916 - 1920, indicated that both the single and double crosses were higher yielders on the average than the varieties, and the double crosses were somewhat superior to the single crosses.\(^{(16)}\) The experiment shows, however, that certain single crosses may be entirely satisfactory from the standpoint of yield.

The superiority in yield of \(F_1\) crosses over the original variety from which the selfed strains were obtained, in a four year trial was demonstrated in Nebraska in 1922.\(^{(17)}\) Richey and Mayer in a paper written a few years later report on a rather more complicated breeding experiment - the crosses from selfed lines isolated from the \(F_2\) generations of a superior cross - and bring out the fact that present day methods of corn breeding are primarily those of controlled selection.
They emphasise that the combination of selfed lines which contain the greatest number of favourable growth factors is the ultimate aim of the maize breeder. Three of the better producing crosses reported in this paper averaged 30% higher in yield than the better parent variety. F₁ crosses proved triumphant, taking the five highest for places in corn yield contests conducted by the Iowa Corn and Small grain Growers' Association in 1924 and in four cases an inbred strain was used as one or both of the parents. The highest yield, 51.3 bushels per acre, was obtained from a cross entered by the United States Department of Agriculture, while the highest yielding commercial variety, a strain of Reid's Yellow Dent, produced only 39.1 bushels. H. D. Hughes who has been associated with H. A. Wallace in extensive tests at Ames, Iowa, has said: 'From the results secured thus far it is entirely evident that decidedly better yields can be secured from hybridising pure lines than can be had from the best standard varieties of which we know. The data would also indicate that extensive ear-row breeding with subsequent crossing of the best lines, even when carried through a long period of years, cannot be expected to give the results to be had from the production of those pure lines and the use of F₁ seeds.' In 1924 and 1925 results obtained at the University Farm, St. Paul, Minnesota indicated that double crosses in which selfed lines of desirable appearance are used may be expected to yield more than the present standard varieties. During the course of experiments reported by Richey in 1925, the average yield of three F₁ crosses between lines of corn self-fertilised for six generations was 30% more than that of the parent variety and the consistency of the data showed clearly, he said, that this superiority was not due to chance. It was made clear that the principal role of self-fertilisation is to isolate definite lines differing from each other.
other among which selection may be practised.

Richey considers, with justice, that it is necessary for practical reasons to have inbred lines that are productive in themselves. Unfortunately, the data suggest that there is little or no relation between the productiveness of the self-fertilised lines and that of their crosses and that the final value of the lines for crossing must be determined by comparisons of the productiveness of their crosses. To obtain a variety which will be as vigorous as the original variety. Two years later Richey is able to state that some of the selfed lines being obtained were productive enough to render entirely practical their use in single crosses for commercial seed production.

This statement invalidates the objection of Hayes to the use of closely inbred lines to which reference was made earlier on. The advantage held by double crosses in having an extended time of flowering of course still holds good. There have been no critical comparisons between single and double crosses, the parent lines of which have all been reasonably productive. The question as to which kind of crosses will yield more therefore is unsettled. Furthermore Richey expresses his opinion that the question will remain an open one for some time; though the method eventually chosen will depend on matters of economy, practicability and the like. Both methods have the disadvantage that crossed seed must be produced anew for each season's planting. Double crossing requires that three separate crosses rather than one must be made each year; so unless the double cross has outstanding advantages it would seem that, if a cross is to be used, the single cross is more likely to find favour.

An ideal aim for the corn-breeder is the production of a "synthetic variety" which, being homozygous for all desirable growth factors, will breed true to type each year and suffer no diminution of vigour. Once this desideratum was obtained great care would be needed to maintain the stock in the required state of purity. Seed might be
might be produced in isolated breeding plots as in the routine of the multiplication of special pure lines of cotton which is customary today. However, the production of improved varieties synthetically by a crossing of several selfed lines and subsequent selection aims at the improvement of the variety without the necessity of making an F₁ cross each year.²⁰ Hayes expressed the cautious opinion that it will be very difficult to obtain a variety which will be as vigorous as certain F₁ crosses though he agreed that when a single character, such as disease resistance, is of outstanding importance the plan appears to be a sound one. He also remarked that the extent to which F₁ crosses will exceed synthetic varieties in yielding ability will depend on the extent to which good vigour and homozygosis can be associated in selfed lines.

Richey in his recent publication(6) discusses the possible use of the so-called "synthetic varieties". He does not approach this subject from its ideal aspect, that is the recombination of pure lines and the ultimate selection of a type which is homozygous for the greatest possible number of favourable factors; instead he returns to the old fetish of hybrid vigour which he says will be obtained by intercrossing enough selfed lines that random pollination will occur "sufficient to insure productiveness". He says no more than that "a synthetic variety consisting of a mixture of crosses among these lines grown under conditions of random pollination, as in ordinary corn culture, will be maintained in a high degree of hybridity and at the same time should yield more than the ordinary variety". This is indeed taking a very near-sighted view of the object of the production of a synthetic variety which, we consider, should be the blending of various good types with such continual selfing, crossing and selection as should utterly preclude "conditions of random pollination", much in the manner in which for example, new wheat varieties are brought into being, though in the latter case, cross-pollination
cross-pollination being uncommon, the procedure is much simpler.

Richey does not hold forward hope that the yields obtained will be greater than those from single or double crosses: however it must be remembered that his idea of a "synthetic variety", as shown above, is possibly more immediately practical than "idealistic".

We hope, in conclusion, that the foregoing survey of recent experiments and theories on maize breeding, chiefly gathered from the Sibylline leaves of departmental bulletins, may serve as an introduction or apologia for the work carried out during the past year at the Imperial College, which is hereafter described.

Our selections were therefore made solely on ear and grain characters.

The farm crop was harvested on 22nd - 23rd October, in dry weather, and carted into the yard to be hulked. As the cobs were hulked we examined them, and they proved to be a very heterogeneous collection, chiefly poor, with the exception of a lack of uniformity in shape and grain type; the lengths varied from six to ten and a half inches; and width was marked. The cobs were fairly uniformly rich, and (by estimation) the 15-20 type was predominant, but 12-, 15-, and 16-20 types were all well represented.

We feel it advisable to give in some detail our criteria of selection, so that our successors can have some appreciation of the basis on which we are acting.

Yield, in this case, is the most important factor in profitability, and accordingly we have made those factors which contribute directly to yield our main considerations in trying to evolve an improved maize.

"Yield" in maize may be analysed in a manner analogous to that used by Harland (22) for cotton.
PART B.

AN ACCOUNT OF PROGRESS MADE DURING
1928 - 29.

I. Selection of Material.

Having a very limited stock of selected and exotic seed (dealt with later) left us by last year's workers on maize, we were obliged to start from the beginning and to pick out cobs from the farm crop. Unfortunately we did not see this crop growing, and our selections were therefore made solely on cob and grain characters.

The farm crop was harvested on 22nd - 23rd October, in dry weather, and carted into the yard to be husked. As the cobs were husked we examined them, and they proved to be a very heterogeneous collection, mostly poor, with the tips ill-set, and a lack of uniform colour, shape and grain type; the lengths varied from six to ten and a half inches; and xenia was marked. The cobs were fairly uniformly ripe, and (by estimation) the 14-row type was predominant, but 12-, 16-, and 18-row types were all well represented.

We feel it advisable to give in some detail our criteria of selection, so that our successors can have some appreciation of the ideal at which we are aiming.

In this case, yield, is the most important factor in profitability, and accordingly we have made those factors which contribute directly to yield our main considerations in trying to evolve an improved maize.

1. "Yield" in maize may be analysed in a manner analogous to that used by Harland for cotton:
   1. Weight of grain per cob
   2. Depth of grain i.e., Distance from shell to tip of grain
   3. Number of rows
   4. Strength of tip and butt
   5. Lack of cobs.
<table>
<thead>
<tr>
<th>Yield of grain per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of grain per cob</td>
</tr>
<tr>
<td>Size of cob</td>
</tr>
<tr>
<td>No. of cobs per plant</td>
</tr>
<tr>
<td>Weight of individual grains</td>
</tr>
</tbody>
</table>

Of these factors, some are controllable by the geneticist, and some by the agriculturist. The number of cobs per plant is largely a function of the spacing (plants per acre) as far as our limited experience extends. The number of ovules per cob is obviously the limiting factor to the number of grains per cob, and the loss from ovule to grain number may be partly hereditary - imperfect pollination may be due to climate only, but fertility is often genetic. Going still further, the greatest number of ovules is obtained from the cob of the greatest surface area; but all shapes of grain do not fill this surface equally well, and we must further select for efficiency in grain shape, and this, so far as we know, in common with other morphological features, is also hereditary. The most effective shape will depend upon the number of rows per cob.

Our requirement then is that particular combination of such features as grain shape and row number which gives maximum productivity.

The points we looked for in the cob were therefore:

1. Size of cob.
2. Packing of grain, - (a) between rows (b) along rows.
3. Depth of grain i.e., distance from point of attachment to tip of grain.
4. Bareness of tip and butt.
5. Lack of gaps.

Other
PLAN OF MAIN EXPERIMENTAL PLOTS IN FIELD "D".

Drawn to scale. 1 cm. = 20 feet.

B and C are exact replicas of A.
Rows 4 feet apart.
Plants 3 feet apart.
Total area under crop 25 x 128 square yards = 2/3 acre.
Drains between plots 1 foot wide x 6 inches deep.

Soil: light silty

Weeds: Cyperus rotundus, "nut grass", abundant
Cynodon dactylon, "devil grass"
Mimosa pudica, "sensitive plant"

Previous crop: Maize

Adjacent crops: Coix (on East), Eleusine (on West). 

\[\text{PLAN OF MAIN EXPERIMENTAL PLOTS IN FIELD "D".}\]

\[\text{Drawn to scale. 1 cm. = 20 feet.}\]

\[\text{B and C are exact replicas of A.}\]
\[\text{Rows 4 feet apart.}\]
\[\text{Plants 3 feet apart.}\]
\[\text{Total area under crop 25 x 128 square yards = 2/3 acre.}\]
\[\text{Drains between plots 1 foot wide x 6 inches deep.}\]

\[\text{Soil: light silty}\]

\[\text{Weeds: Cyperus rotundus, "nut grass", abundant}\]
\[\text{Cynodon dactylon, "devil grass"}\]
\[\text{Mimosa pudica, "sensitive plant"}\]

\[\text{Previous crop: Maize}\]

\[\text{Adjacent crops: Coix (on East), Eleusine (on West).}\]
Other characters also received attention. In commerce a large grain is looked upon with more favour than a small one, therefore depth in a vertical direction was considered an asset. An even cob, without twisted rows, is also a help to the grower who sells his maize unthreshed. We have no information as to the likes and dislikes of the market in regard to colour, and we selected our cobs irrespective of this feature, so long as the grain was of good lustre. As to optimum row number per cob we were also working in the dark, and played for safety by selecting over the whole range of this character.

Thirty cobs were selected, and notes made on each as regards length, thickness, shape, packing, denting, colour, number of rows, bareness of tip, and amount of xenia observed. A few pounds of the ordinary mixed farm grain were also taken for comparison.

The selected cobs were threshed by hand, great care being taken to avoid mixing, and half of each cob's produce was sown as detailed below, and half put aside in cigarette tins in compliance with the demands of the ear-to-row "remnant" method of breeding, discussed elsewhere, which at that time we intended to follow. The grain in the tins was thoroughly air dried first, to check Aspergillus spp., and then fumigated with CS₂; it was examined periodically.

II. Lay-out of Plots and Field Operations.

Site:— The main plots had perforce to be situated in Field D of the College Farm, on a rather unsuitable piece of land. This field showed soil variation to the eye even when under bare fallow, and this unevenness was reflected, as we feared, in the crop.

A diagram of the plots in Field D is given opposite. The legend to the diagram gives particulars of the field.
TEMPERATURES AS DAILY AVERAGES CALCULATED ON WEEK'S RECORD

PLANTING

MAXIMUM

GROUND TEMP.

MINIMUM

NOVEMBER DECEMBER JANUARY FEBRUARY MARCH
RAINFALL IN TWO-DAY TOTALS 1928-1929

TOTAL FALL FROM PLANTING [NOV. 15TH]
TO HARVEST [MAR. 18TH]
= 14.63"
Lay-out.- The thirty selected "varieties" and the control were sown in rows in triplicate, as shown in the diagram. Each row contained 25 plants, and the field thus contained 75 plants of each "variety".

System of reference.- As care was taken to keep distances accurate at planting time, no system of labelling plants was necessary, as any individual plant could always be referred to as Plant X, Row Y, Plot A, B or C, always counting from a given corner. Stakes at the end of every tenth row were a great convenience in counting.

Agricultural Operations.- The seed was got in under good weather conditions on the afternoon of the 15th November. A disc harrowing the previous week had left the field in fair tilth. Three seeds per hole, on the flat, were sown; braiding was general by the fourth day and the final stand was nearly 100%. Waterlogging before the ditches were functioning, however, caused about 5% of blanks, and these we had filled up by transplants on 4th December (19 days after sowing). Incidentally, the transplants never over­ came the shock and we agree with last year's workers on maize that resowing would be the better method.

The normal farm practice was followed in regard to cultivation, the plots being mule-hoed twice, and hand-hoed once when the plants started to meet. Thinning to one plant per hole was carried out on 14th December, (one month after planting) when the average height would be about 2 feet. No manure was given, but with a normal and favourable rainfall (November, 12"; December, 6"; January onwards infrequent showers; see charts opposite) the plants grew apace: indeed it may be stated here that agricultural speaking the crop was

*It should be noted that this is not a formal yield trial. The plots are primarily observation plots, and the repetition is to give as big a range of conditions as possible.*
and a great success, constituted in fact one of the show crops of the farm, appearing some four to six days before the latest tile. Not a few abnormalities were noticed in the inflorescence (e.g., parthenocarpy in cornsilk, etc.), but again apparently with no reference to strain. Accurate note-book records of plant and row performances were kept, observations being made at least once a week.

Great variation was noticed from the start, but this variation was as much intra-row as inter-row; nevertheless, the rows were constant enough in some characters to be dignified by the title of strains, and henceforth when we speak of strains we mean the produce of single cobs.

No exact measurements of growth were made - the great soil variation would have nullified any comparative results - but eye observation allowed us to classify strains into several arbitrary grades as regards rate of growth and general well doing.

No difference as between strains was observed in rate or percentage of germination (which could be dissociated from soil variation) and we do not think it would serve any useful purpose to give germination tables, as all strains were uniformly good. One strain showed a small percentage of white seedlings, probably chlorophyll deficient, in all three plots; these soon died, but, as in many cases the remaining plants would be heterozygous for this character, this strain received a very bad mark.

The points sought were sturdiness, large leaf surface, and glossy green colour, height (as indicative of maturity in a rough way) rapidity of growth; and, as within varieties, constancy of such characters as these, indicating the degree of homozygosity.

The conditions were so favourable to growth of maize, that no differential susceptibility to drought or to heat or to waterlogging was expressed, though doubtless variation in such physiological characteristics does exist. Insect attack was also so slight as not to allow of any differentiation in resistance to attack.
The plants were generally, but not invariably protandrous, the tassel appearing some four to ten days before the topmost silk. Not a few abnormalities were noticed in the inflorescence (haplophilote inflorescences etc.) but again apparently with no reference to strain. Flowering and tillering counts were made on January 15th., and maturity noted at all stages.

### Calendar of Events - Resume

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th November</td>
<td>Maize sown</td>
</tr>
<tr>
<td>19th November</td>
<td>Braird general (4 days after sowing)</td>
</tr>
<tr>
<td>4th December</td>
<td>Transplanting when necessary (19 days)</td>
</tr>
<tr>
<td>7th December</td>
<td>Many plants 1' high (22 days)</td>
</tr>
<tr>
<td>14th December</td>
<td>Thinning (29 days)</td>
</tr>
<tr>
<td>21st December</td>
<td>Laphygra noticed (36 days)</td>
</tr>
<tr>
<td>25th December</td>
<td>Prop roots first noticed (40 days)</td>
</tr>
<tr>
<td>28th December</td>
<td>First side-tillers observed (40 days)</td>
</tr>
<tr>
<td>29th December</td>
<td>Many plants 6' high (44 days)</td>
</tr>
<tr>
<td>7th January</td>
<td>First tassel (58 days)</td>
</tr>
<tr>
<td>11th January</td>
<td>First silk (57 days)</td>
</tr>
<tr>
<td>18th January</td>
<td>Bagging (64 days)</td>
</tr>
<tr>
<td>21st January</td>
<td>Diatracea borers noticed (67 days)</td>
</tr>
<tr>
<td>29th January</td>
<td>&quot;Auxiliary&quot; cobs noticed (75 days)</td>
</tr>
<tr>
<td>1st February</td>
<td>Smut first noticed (78 days)</td>
</tr>
<tr>
<td>16th February</td>
<td>Selections made in the field (84 days)</td>
</tr>
<tr>
<td>16th February</td>
<td>Entomologist's visit to plots (84 days)</td>
</tr>
<tr>
<td>26th February</td>
<td>Lodging due to stem-borer observed (93 days)</td>
</tr>
<tr>
<td>27th February</td>
<td>Earliest cobs mature (95 days)</td>
</tr>
<tr>
<td>16th March to</td>
<td>Harvest (114 - 118 days)</td>
</tr>
<tr>
<td>22nd March</td>
<td>Shelling percentages found</td>
</tr>
</tbody>
</table>

1 month after Harvest
Selfing was done with the idea of stealing a march on time. By the "remnant" method, as explained elsewhere, the seed from the original cobs is divided into two lots of which one is sown and put aside, and the one in the field having proved its worth, the remaining seed or remnant is grown in an isolated plot to give more or less self-fertilised seed - we believe "sib-fertilized" seed is the technical expression. By making what might be called an intelligent guess at the strains which were to prove best, we could self-fertilise some plants of these as they grow, and thus be a generation ahead on the road to homozygozity if the strains really did prove to be superior upon harvesting. Accordingly we selfed some 25 plants, chosen on the basis of general appearance of plant and row.

Technique of selfing. - The technique is more easily preached than practised. Both the male and the female inflorescences have to be bagged to exclude extraneous pollen, the male at least 48 hours before pollen is needed and the female of course before silk is showing.

We used 14-pound opaque paper bags, which did not prove very satisfactory; giving 25% of set cobs; this however may have been partly due to the wet weather experienced at the time, or to the fact that we could not obtain bags early enough to self the first cobs on the plant, and the second and third cobs were often poor specimens which would not have set seed in any case. Bagging was performed on the 18th. January (64 days after sowing), and three pollinations were made, on 21st., 25th. and 29th. January.

V. Selection

*See note in Appendix on suggestions for selfing in future.*
V. Selection of Plants in the Field.

On 16th February (84 days after planting) the crop was sufficiently advanced to allow of a first selection taking place. All rows were carefully examined and those which did not come up to our standard - a very lenient one at this stage - and which had been consistently poor all through the early stages, were discarded from further observations.

A more intensive examination of the selected strains was then undertaken and a detailed examination made of the best of the typical plants within each strain.

Uniformity within the strain was considered an important factor in selecting the rows. General vigour, as indicated by height and leaf breadth, and indicative of high yield, were also considered important. Attention was also paid to what Engledow would call ancillary yield characteristics - down-turning habit of cob (to run off rain), bareness of cob tip, thickness of stem, smut and rust resistance, and so on.

The selected plants were then described on a standardized form we drew up. The height of the plant, number and type of leaves, thickness of stem, proportion of tillers and prop roots were noted amongst vegetative characters. The numbers of large and small and "auxiliary" cobs, and the down-turning habit/ tightness of bracts, height above ground of highest cob, and node number of lowest cob were also noted.

At a later date (9th March; 105 days after planting) all strains were classified as "late", "early" or "intermediate".

VI. Harvest.

*By "auxiliary" we mean small cobs produced in the axils of the bracts of the main cobs. An undesirable feature, probably controllable by closer spacing.
VI. Harvest.

This occupied five afternoons, from March 18th to 22nd, (114 - 118 days after planting). The crop was got in good weather, and was in excellent condition.

The produce of each plant in the selected strains was weighed individually, in the field.

The discarded strains were weighed as rows but not as individual plants.

Yield data are given in the next section.

The grain was stored in sacks in the Farm Office and put in the open every day for a week to prevent heating. Observations on the characteristics of the selected cobs now were made. After thorough drying for a month, the grain was threshed by hand.

VII. Yield Data.

As mentioned in the details of harvesting supra, our strains with selected or selfed plants were kept separate from our unselected strains and treated in more detail.

All our weighings were made in the field on maize husked but not shelled and our yield figures are thus liable to two sources of error:

(a) There may have been a differential loss of moisture on drying, as between strains. This has been neglected.

(b) The proportion of grain to cob may have been different for different strains. It was found impracticable however to shell and weigh separately the produce of nearly 1,000 cobs in the field. As a compromise, the shelling percentages of the various selected strains were found later in the year; they proved to average 80% and the majority of strains shelled actually 80%.

The total weight of husked maize obtained from the plots in Jacob's scales, on the steel-yard principle, were used and found satisfactory.
in Field D., just under 2/3 acre in all, was 1,950 lb. This is equivalent to a yield per acre of over 3,000 lb., and compares favourably with the figures of Bruce and Savile, last year’s experimenters on maize in Trinidad, namely 603 lb. of husked maize from a half an acre. Also accordingly.

The yield of 1,950 lb. is made up as follows:

<table>
<thead>
<tr>
<th>TABLE I.</th>
<th>Weight harvested</th>
<th>Weight per strain (300 sq. yds.)</th>
<th>Weight per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unselected strains. (16)</td>
<td>60.2</td>
<td>2976</td>
<td></td>
</tr>
<tr>
<td>Selected strains. (14)</td>
<td>70.5</td>
<td>3412</td>
<td></td>
</tr>
<tr>
<td>Total. (30 strains)</td>
<td>65.0</td>
<td>3146</td>
<td></td>
</tr>
</tbody>
</table>

It will be observed that the strains selected on plant characters averaged considerably more than those unselected when the test of the weighing machine was applied; hence we must have been on the right lines when selecting for yield in the plot; but this correlation, between high yields and selected strains holds up to a point only: as we found that the five best unselected strains weighed more than the five worst selected strains. Thus selection for yield must be regarded (as it always is of course) as merely supplementary to the data given by the steel-yard. As varieties become more highly evolved, and as the degree of difference between them narrows, in this or any other crop, less reliance is placed on estimation and

As a matter of interest we append the following figures:

<table>
<thead>
<tr>
<th>Official American (U.S.A.) yield</th>
<th>1927 - 1563 lb. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1928 - 1512 lb. per acre</td>
</tr>
<tr>
<td></td>
<td>1929 - 1240 lb. per acre</td>
</tr>
<tr>
<td>Rhodesian yield</td>
<td>1923 - 560 lb. per acre</td>
</tr>
</tbody>
</table>

The figures of course refer to shelled grain, and should be multiplied by 4/3 to make them comparable with those given above.
and more and more on the formal yield trial with its accurate weighings; but at this primary stage in our selections we can choose plants or strains likely to prove good yielders by observation of the growing crop, and we can frame our weighings of strains to be detailed or otherwise accordingly.

The plants in our selected rows were weighed individually in order to gain some idea of the fluctuation in yield from plant to plant, and to obtain an indication of the significance of the figures showing the mean yield per plant of the strains. It should be noticed that we are dealing with strains still in a heterozygous condition and, although we claim that our figures are reliable for this generation, no reliance should be placed on their application to progeny generations.

The yield of the fourteen strains selected on field characters are tabulated below:

**TABLE II.**

Showing the yields in ounces of the fourteen selected strains, in order of yield per plant

<table>
<thead>
<tr>
<th>No. of Strain</th>
<th>Weight per strain (oz. (lb.))</th>
<th>No. of Plants</th>
<th>Mean Yield per Plant</th>
<th>Standard error (on basis of No. of plants in Column 3.)</th>
<th>Standard error as a percentage of the Mean Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1248.00 (76.0)</td>
<td>63</td>
<td>17.91 ± 5.05</td>
<td>± .330 oz.</td>
<td>± 4.23%</td>
</tr>
<tr>
<td>2.</td>
<td>1278.00 (80.0)</td>
<td>65</td>
<td>17.16 ± 4.71</td>
<td>± .3044</td>
<td>± 4.75</td>
</tr>
<tr>
<td>3.</td>
<td>1275.00 (79.5)</td>
<td>69</td>
<td>17.47 ± 5.24</td>
<td>± .2488</td>
<td>± 4.90</td>
</tr>
<tr>
<td>4.</td>
<td>1358.00 (84.5)</td>
<td>74</td>
<td>17.24 ± 6.23</td>
<td>± .2822</td>
<td>± 4.83</td>
</tr>
<tr>
<td>5.</td>
<td>1150.00 (72.0)</td>
<td>65</td>
<td>17.58 ± 6.66</td>
<td>± .2822</td>
<td>± 4.00</td>
</tr>
<tr>
<td>6.</td>
<td>1130.00 (70.5)</td>
<td>64</td>
<td>17.58 ± 6.66</td>
<td>± .2822</td>
<td>± 4.00</td>
</tr>
<tr>
<td>7.</td>
<td>1125.00 (70.5)</td>
<td>64</td>
<td>17.58 ± 6.66</td>
<td>± .2822</td>
<td>± 4.00</td>
</tr>
<tr>
<td>8.</td>
<td>1071.00 (67.0)</td>
<td>63</td>
<td>17.00 ± 7.97</td>
<td>± .2690</td>
<td>± 4.29</td>
</tr>
<tr>
<td>9.</td>
<td>1052.00 (65.5)</td>
<td>62</td>
<td>16.96 ± 8.26</td>
<td>± .2760</td>
<td>± 4.14</td>
</tr>
<tr>
<td>10.</td>
<td>1138.00 (71.0)</td>
<td>70</td>
<td>16.26 ± 9.06</td>
<td>± .2760</td>
<td>± 3.96</td>
</tr>
<tr>
<td>11.</td>
<td>1108.00 (69.5)</td>
<td>69</td>
<td>16.00 ± 9.06</td>
<td>± .2760</td>
<td>± 4.28</td>
</tr>
<tr>
<td>12.</td>
<td>993.00 (61.5)</td>
<td>63</td>
<td>16.00 ± 9.06</td>
<td>± .2760</td>
<td>± 3.96</td>
</tr>
<tr>
<td>13.</td>
<td>875.00 (64.5)</td>
<td>58</td>
<td>16.00 ± 9.06</td>
<td>± .2760</td>
<td>± 3.96</td>
</tr>
<tr>
<td>14.</td>
<td>945.00 (61.5)</td>
<td>66</td>
<td>16.00 ± 9.06</td>
<td>± .2760</td>
<td>± 3.96</td>
</tr>
<tr>
<td>15770.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to these fourteen strains we give such details as
as we have of five strains which were not selected in the field, but which justify their inclusion by their good yields.

TABLE III.

Yields of five additional superior strains.

<table>
<thead>
<tr>
<th>No. of Strain</th>
<th>Weight per Strain</th>
<th>Assumed No. of plants</th>
<th>Mean Yield per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.</td>
<td>80.0 lb.</td>
<td>66</td>
<td>19.36</td>
</tr>
<tr>
<td>16.</td>
<td>52.0 (3/4 plot)</td>
<td>44</td>
<td>12.88</td>
</tr>
<tr>
<td>17.</td>
<td>68.0</td>
<td>66</td>
<td>16.80</td>
</tr>
<tr>
<td>18.</td>
<td>65.5</td>
<td>66</td>
<td>15.60</td>
</tr>
<tr>
<td>19.</td>
<td>60.0</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

The fourteen strains of Table II., then, together with the five of Table III., i.e., nineteen strains in all, are those which we deem worthy of further trial.

VIII. Some notes on the Selected Strains.

The yields of the nineteen chosen strains have already been given but we append a few more details, to give a clearer picture of the strains. In cases where a character fluctuated our description is based on a typical plant, a plant with as many modal characteristics as possible being designated "typical".

TABLE IV.
TABLE IV. Details of the nineteen Strains for further trial

<table>
<thead>
<tr>
<th>Strain</th>
<th>Height in feet</th>
<th>No. of leaves per plant</th>
<th>Inclination of cob from vertical</th>
<th>Height of top cob above ground</th>
<th>Mean row number of cobs.</th>
<th>% of plants with &gt;1 good cob</th>
<th>Shelling % (on mean of 20 cobs)</th>
<th>Tightness of bracts</th>
<th>Colour of grain in mass</th>
<th>Maturity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>16</td>
<td>30°</td>
<td>6 feet</td>
<td>12.94</td>
<td>60</td>
<td>81%</td>
<td>Tight</td>
<td>Golden</td>
<td>V. late</td>
<td>Large side tiller</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>17</td>
<td>120°</td>
<td>5½</td>
<td>14.11</td>
<td>70</td>
<td>80</td>
<td>-</td>
<td>Reddish</td>
<td>V. late</td>
<td>25% rust.</td>
</tr>
<tr>
<td>3</td>
<td>10½</td>
<td>13</td>
<td>80°</td>
<td>5½</td>
<td>15.04</td>
<td>65</td>
<td>83</td>
<td>Tight</td>
<td>Golden</td>
<td>Late</td>
<td>Many &quot;auxiliary cobs&quot;</td>
</tr>
<tr>
<td>4</td>
<td>Tall</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Early</td>
<td>Thick stems</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>15</td>
<td>30°</td>
<td>3</td>
<td>13.40</td>
<td>50</td>
<td>80</td>
<td>Medium</td>
<td>Golden</td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>15</td>
<td>85°</td>
<td>5</td>
<td>14.92</td>
<td>60</td>
<td>81</td>
<td>Loose</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Low</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>7½</td>
<td>14</td>
<td>15°</td>
<td>4</td>
<td>15.30</td>
<td>55</td>
<td>80</td>
<td>Tight</td>
<td>Golden</td>
<td>Early</td>
<td>Large reflexed bract tips</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>13</td>
<td>140°</td>
<td>5½</td>
<td>14.03</td>
<td>45</td>
<td>74</td>
<td>Loose</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>15</td>
<td>40°</td>
<td>5</td>
<td>14.38</td>
<td>40</td>
<td>80</td>
<td>Loose tip</td>
<td>Reddish</td>
<td>Late</td>
<td>20% rust</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>14</td>
<td>50°</td>
<td>5½</td>
<td>14.52</td>
<td>60</td>
<td>80</td>
<td>Tight</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>13</td>
<td>45°</td>
<td>3½</td>
<td>14.70</td>
<td>25</td>
<td>84</td>
<td>Tight</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td>15</td>
<td>20°</td>
<td>5½</td>
<td>13.87</td>
<td>40</td>
<td>77</td>
<td>Tight</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>15</td>
<td>45°</td>
<td>6½</td>
<td>15.04</td>
<td>40</td>
<td>80</td>
<td>Medium</td>
<td>Yellowish</td>
<td>Early</td>
<td>Thick stems</td>
</tr>
<tr>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.53</td>
<td>-</td>
<td>79</td>
<td>-</td>
<td>Golden</td>
<td>V. late</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14.33</td>
<td>-</td>
<td>76</td>
<td>-</td>
<td>Golden</td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Tall</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14.13</td>
<td>-</td>
<td>89</td>
<td>-</td>
<td>Golden</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Tall</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14.32</td>
<td>-</td>
<td>81</td>
<td>-</td>
<td>Golden</td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Tall</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16.40</td>
<td>-</td>
<td>76</td>
<td>-</td>
<td>Golden</td>
<td>Late</td>
<td></td>
</tr>
</tbody>
</table>
Some details are also appended of the actual cobs that are being handed over to our successors.

**TABLE V.**

Details of the actual cobs for further trial.

<table>
<thead>
<tr>
<th>Strain</th>
<th>Designation of plant</th>
<th>Whether selfed or open pollinated</th>
<th>No. of cobs</th>
<th>Weight of cobs Oz</th>
<th>Row No. of cobs</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M.P.2901</td>
<td>Selfed</td>
<td>1</td>
<td>9</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M.P.2902</td>
<td>Selfed</td>
<td>1</td>
<td>10</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M.P.2903</td>
<td>Open</td>
<td>1</td>
<td>21</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M.P.2904</td>
<td>Open</td>
<td>2</td>
<td>-</td>
<td>14 + 16</td>
<td>Good tips</td>
</tr>
<tr>
<td>2</td>
<td>M.P.2905</td>
<td>Selfed</td>
<td>1</td>
<td>10</td>
<td>16</td>
<td>Well packed between rows</td>
</tr>
<tr>
<td>2</td>
<td>M.P.2906</td>
<td>Open</td>
<td>1</td>
<td>15</td>
<td>14</td>
<td>Ideal cob</td>
</tr>
<tr>
<td>3</td>
<td>M.P.2907</td>
<td>Open</td>
<td>1</td>
<td>16</td>
<td>16</td>
<td>Large grain</td>
</tr>
<tr>
<td>4</td>
<td>M.P.2908</td>
<td>Selfed</td>
<td>1</td>
<td>5</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>M.P.2909</td>
<td>Open</td>
<td>2</td>
<td>21</td>
<td>12 + 12</td>
<td>Long narrow cobs</td>
</tr>
<tr>
<td>6</td>
<td>M.P.2910</td>
<td>Open</td>
<td>2</td>
<td>24</td>
<td>14 + 16</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>M.P.2911</td>
<td>Open</td>
<td>2</td>
<td>24</td>
<td>16 + 16</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>M.P.2912</td>
<td>Selfed</td>
<td>1</td>
<td>6</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>M.P.2913</td>
<td>Open</td>
<td>2</td>
<td>33</td>
<td>20 + 20</td>
<td>Small grain. Even</td>
</tr>
<tr>
<td>8</td>
<td>M.P.2914</td>
<td>Open</td>
<td>2</td>
<td>31</td>
<td>12 + 14</td>
<td>Reddish grain</td>
</tr>
<tr>
<td>9</td>
<td>M.P.2915</td>
<td>Open</td>
<td>1</td>
<td>23</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>M.P.2916</td>
<td>Open</td>
<td>2</td>
<td>26</td>
<td>16 + 16</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>M.P.2917</td>
<td>Open</td>
<td>1</td>
<td>16</td>
<td>16</td>
<td>Good tip</td>
</tr>
<tr>
<td>12</td>
<td>M.P.2918</td>
<td>Selfed</td>
<td>1</td>
<td>17</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>M.P.2919</td>
<td>Open</td>
<td>2</td>
<td>25</td>
<td>14 + 14</td>
<td>Poor between rows</td>
</tr>
<tr>
<td>14</td>
<td>M.P.2920</td>
<td>Open</td>
<td>1</td>
<td>11</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>M.P.2921</td>
<td>Open</td>
<td>1</td>
<td>12</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>M.P.2922</td>
<td>Open</td>
<td>1</td>
<td>11½</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>M.P.2923</td>
<td>Open</td>
<td>1</td>
<td>15½</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>M.P.2924</td>
<td>Open</td>
<td>1</td>
<td>13½</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>M.P.2925</td>
<td>Open</td>
<td>1</td>
<td>11</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

*The "annual-page" system of nomenclature has been here adopted.*
Our predecessors of last year made the laudable experiment of introducing some exotic varieties to Trinidad. The introduced varieties were all from U.S.A. (3) and the seed which was handed to us had been once grown in Trinidad. Bruce and Savile (3) found that these Americans did badly in Trinidad, being stunted and badly rusted, producing small cobs with poor grain and flowering prematurely.

Four varieties were handed over to us, but unfortunately one, Pride of Saline, was accidentally ploughed in leaving us to harvest Reid Yellow Dent, Kansas Sunflower and Fred White.

The varieties were sown in isolated plots (400 yards is the minimum distance between such plots to prevent any chance of cross pollination) and given the same treatment as the main plots in Field D., but got in addition some 2/3 ounce of ammonium sulphate per plant in the fourth week.

Braird was excellent, and growth for the first month was as good as that of the local maize but then came to a standstill in the case of Fred White and Kansas Sunflower. Very few plants of these varieties reached 6 feet, and about 4 feet would be the modal height. Reid Yellow Dent did rather better, averaging 5 feet; this variety was almost free of rust while the other two suffered badly, so that rust and lack of height may be a case of cause and effect.

Flowering was premature (see Table VI.), and the cobs were small, even so averaging less than two per plant.

Table VI.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Date of flowering</th>
<th>Time from sowing to flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred White</td>
<td>23rd Nov.</td>
<td>6th Jan.</td>
</tr>
<tr>
<td>Kansas Sunflower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reid Yellow Dent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fred White</td>
<td></td>
<td>5 ft.</td>
</tr>
<tr>
<td>Kansas Sunflower</td>
<td></td>
<td>4 ft.</td>
</tr>
<tr>
<td>Reid Yellow Dent</td>
<td></td>
<td>6 ft.</td>
</tr>
</tbody>
</table>

All heights to topmost ligule.
Rust, as stated, was in some cases so heavy as effectually to cover up all leaf surface. An occasional smutted plant was noticed in all varieties. Our experiences, in short, tally with those of Bruce and Savile last year.

It is a wise thing to have as big a reference collection as possible when dealing with plant-breeding schemes, and we recommend that such of these varieties as are left be carried on. None of them compare with the local maize in cropping power; but they may possess some desirable ancillary yield feature which is lacking in the local maize and could be incorporated into it if desired. The reference collection should be the plant-breeders' scrap-heap", to quote Cheesman.

Moreover: Bruce and Savile introduced this seed, probably already fairly homozygous, and grew it in isolated variety plots; we have done the same and an effect akin to self-fertilisation must be in progress. May not the apparent failure of these varieties then be due to the loss of vigour resultant upon inbreeding, which is a well-known phenomenon in maize, and discussed elsewhere in this paper? A solution to this problem would be obtained from observation of the effects of crossing two of the American varieties with one another.

And again: "acclimatization" after some years is known to
take place in some cases - instance the introduction to the United
States of Egyptian cottons;\(^{(23)}\) which "did" badly at first and the
introduction of Upland cotton to Africa - and this may occur in the
case of maize. Such "acclimatization" is probably a genetic rather
than a physiological adaptation to environment; (the deterioration of
the introduced varieties should not be confused with that type of
deterioration well-known as "running out" in vegetatively propagated
crops, which recent evidence seems to show is pathological;) probably
no crop is so homozygous that there is no room for a certain amount
of variation occurring, and, as a corollary, survival of the fittest
for the new environment.

If more introductions of exotics are to be made we suggest
that they be from places with an insular climate like that of Trini-
dad. A variety which would do well in Trinidad might be obtained
from such a place as Mauritius or the Philippines or Hawaii.

II. Behaviour of Local Strains selfed last year.

We have to report a complete failure in this line of work.

Four of the selections of Bruce and Savile were handed to
us. Three of them had been kept since the previous October (i.e.,
from October 1927 to October 1928, as "remnants") and carefully
conducted germination tests showed that not one seed was viable.
Seed was also sown in plots, but not one seedling appeared: the seed
looked superficially good and showed no signs of insect or fungus
attack, but instead of germinating it decayed. The fourth selection
had been grown as a single plant for another generation (June to
October 1928) so that the seed we obtained was only a few weeks old,
and was moreover presumably selfed.

This gave an excellent braid; and we had great hopes
of the strain, which was grown in isolation on land kindly lent us
by the Cotton Research Station.
For the first month growth was normal. Then it was observed that the leaves were narrower and had not the dark glossy green colour of ordinary maize. Growth stopped in most cases before the plant was 2 feet high, and the whole plot assumed a very sorry appearance.

All but two plants were sterile (i.e., no female inflorescence was produced) and these two on selfing set no seed.

Our comment is that a strain which shows ill-effects to such a marked degree after one generation of inbreeding must be full of undesirable genes and is better lost.

III. Note on Insects and Fungi.

As a matter of interest we append the following observations, although they are perhaps a little irrelevant to the matter in hand, since as stated elsewhere we found no differential behaviour to insects or fungi, except possibly as regards rust resistance. All insects.

Laphygma frugi-perda. The larvae of this pest, the well-known Fall Army Worms were noted on a small percentage (5% at a guess) of the plants in the main plots on December 21st (36 days after planting). The larvae worked about the growing tips, and attacked plants were characterised by the frass on the adaxial surfaces of the younger leaf laminae. As the plants grew and the attacked leaves emerged, they were seen to be partially eaten away, lending a fretted appearance to the laminae. Attacked plants seemed to suffer little inconvenience but we sent round a boy who placed a nible full of Arsenic and bran (3:1:10, into the centre of attacked plants. The plants soon grew away from the attack. Reid Yellow Dent among the Americans missed the attack.

The small moth borer of sugar cane, Diatraea saccharalis was
was first noticed on the maize on 16th January. We took no remedial measures beyond pulling out 3 or 4 badly infected plants. We are indebted to Mr. W. Cook for the following observations on the plots in D. "Slight primary infestation of D. saccharalis, boring in base of stems, with presence of secondary fly larvae scavengers (Chaetopsis debris; Ortaidae) in the burrows of the caterpillar.

Symptom: dead heart of the maize".

Chloridea (Heliothis) obsoleta, the Corn Ear Worm and a very cosmopolitan pest, was a great nuisance, disfiguring the tips of half the cobs by eating the grain and leaving a mass of debris, often occupied by small secondary larvae. We paid attention to tightness of husk in our selections in case this should have any deterrent effect on the pest.

The predatory Venezuelan Jack Spaniards were our active allies in January.

The White Maize Jassid (Empoasca) was present in very small numbers.

Silvanus gemellatus (Cucujidae), a minute reddish beetle, was present in large numbers in our stored cobs, but apparently did no harm whatsoever.

Fungi.

The only two pathogens observed were rust and smut.

Rust was first noticed on the American varieties, at the end of January. The particular rust present was identified for us as Puccinia maydis (P. zeae). On Kansas Sunflower the spores were so thick as to obliterate the green colour of the foliage, and Fred White suffered almost as badly. Reid Yellow Dent escaped almost scot-free, showing no more signs of rust than the local maize.

A count was made on the main experimental plots in Field D. on 16th February (64 days after planting) to find if there was any differential resistance to rust: no strain was badly enough rusted to have its yield affected, but we consider there is some definite evidence
evidence of diverse degrees of susceptibility. No strain was quite free, but the number of infected plants per strain showed a big variation - just over 5% in the best to over 25% in the worst.

However, maize in Trinidad seems to have become tolerant of rust and to suffer no great harm from it, and we consider it would be a superfluous refinement to discard strains merely on rust susceptibility at this stage.

Up to 5% of plants infected with smut, *Ustilago reiliana* were found in the strains in Field D; these were uprooted and destroyed. Abnormal plants, e.g., those with hemaphrodite inflorescences, were commonly attacked. Cobs chiefly, but also leaves were affected. American varieties and the local strains suffered equally.

In considering the points which we ourselves endeavoured to observe when selecting our maize cobs, it must be remembered that some qualities had of necessity to be neglected in choosing a cob for the association of cobs of the others. Thus, lengthy cobs often were selected despite the fact that the abundance of packing of the grain left something to be desired. This however is in accordance with modern theories regarding cob-type in relation to high yield.

Attention was paid to the rejection of cobs which departed from standard in being bare at tip and having gaps in the rows of grain. These faults may be due to imperfect pollination, but may also be due to the plant being grown in an environment which is so poor.
I. Some Criticisms, Observations and Suggestions.

(a.) Concerning the selection of cobs for seed.

Bruce and Savile in their work at the Imperial College during 1927-28 stated that they selected cobs "by the approved method, i.e., general symmetry, regularity, proportion of grain to cob, and well packed cobs". It is difficult to understand what these workers meant by the "approved method" unless they referred to the show-card method of judging which is already obsolete in the eyes of practical maize breeders. "General symmetry" and "regularity" are almost invariable characteristics of the maize ear so that any departure from this would naturally be an abnormality which would bar the cob from being selected. "Proportion of grain to cob" though apparently an ideal consideration is according to Richey's work, quoted earlier, not necessarily associated with high yield. Recent evidence also suggests that it is not always the most closely packed cobs, which give the highest yield per acre, though close packing was a sine qua non of the old show cobs. A misfortune. Some of the food supply and a failure.

In considering the points which we ourselves endeavoured to observe when selecting our parent cobs, it must be remembered that some qualities had of necessity to be neglected in choosing a cob for the possession of some of the others. Thus, lengthy cobs often were selected despite the fact that the closeness of packing of the grain left something to be desired. This however is in accordance with modern theories regarding cob type in relation to high yield. Mention was made of the rejection of cobs which departed from standard in being bare of tip and having gaps in the rows of grain. These faults may be due to imperfect pollination, but may also be due to the plant being grown in an environment which is so poor
poor, that the cob fails half-way up for lack of food supply. If full cobs are picked out it is ensured at least that plants unthrifty under local conditions are eliminated; and this of course is a fundamental concept of all selection work.

(b) Plant Type.

It was seen that there is little guidance in the literature of maize breeding as to the selection of ideal plants, the general characters of which are indicated only very broadly. We have described in more detail the qualities for which we sought, but whether these qualities are virtues, or whether they are things of indifference is for future determination; though commonsense often gives its homespun sanction to our choice.

Whether a plant bears several cobs or one only is probably partly decided by the spacing and partly by hereditary factors. The growth of too many cobs on one plant may mean that none of the cobs are good but that they are small and contribute but poor grain to the yield. It seems however that there is no reason to limit the selection to plants which bear a solitary ear, as the corn plants which carry two or more cobs may produce a higher yield. Tillering, however, is almost invariably a misfortune. Some of the food supplies are diverted from the main stem, which suffers accordingly, while the ear, if any, which is borne by the tiller is later to maturity than the general crop and is usually small and ill grown.

With regard to the subsidiary points which we considered in selecting our types, we could not agree with Bruce and Savile and other workers who have considered that the bearing of the cobs fairly low down is a very important quality in a strain of maize. The rejection of an otherwise desirable line of plants because the ears are borne out of reach of the labourers, possible somewhat diminutive Indian women, seems to be adding to the difficulties of an already sufficiently complicated task of plant breeding: the extra labour involved.
involved in bending a cornstalk to bring its fruits within easy picking distance seems a small thing when a potential higher yielding strain is under review.

We did favour those plants the cobs of which tended to turn downwards, thus running off the rain; and we also had a strong preference for those ears which were tightly and fully enclosed by their sheathing bracts, as we noted that cobs thus protected were much more resistant to insect attack and fungal disease than were those which presented incomplete barriers to biological enemies.

Table Showing Percentage of Grain in Cob in Cobs of Different Row Numbers

Table Showing Row Numbers of Parent Cobs and Progeny.

<table>
<thead>
<tr>
<th>Strain No.</th>
<th>Row No. of Parent Cob</th>
<th>Mean Row Number of Progeny Cobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>12</td>
<td>12.94</td>
</tr>
<tr>
<td>4.</td>
<td>14</td>
<td>13.77</td>
</tr>
<tr>
<td>3.</td>
<td>14</td>
<td>15.04</td>
</tr>
<tr>
<td>5.</td>
<td>14</td>
<td>13.40</td>
</tr>
<tr>
<td>12.</td>
<td>14</td>
<td>14.70</td>
</tr>
<tr>
<td>7.</td>
<td>14</td>
<td>14.65</td>
</tr>
<tr>
<td>2.</td>
<td>14</td>
<td>14.11</td>
</tr>
<tr>
<td>6.</td>
<td>16</td>
<td>14.92</td>
</tr>
<tr>
<td>13.</td>
<td>16</td>
<td>13.87</td>
</tr>
<tr>
<td>10.</td>
<td>16</td>
<td>14.38</td>
</tr>
<tr>
<td>8.</td>
<td>16</td>
<td>15.30</td>
</tr>
<tr>
<td>14.</td>
<td>16</td>
<td>15.04</td>
</tr>
<tr>
<td>11.</td>
<td>16</td>
<td>14.52</td>
</tr>
<tr>
<td>9.</td>
<td>16</td>
<td>14.03</td>
</tr>
<tr>
<td>16.</td>
<td>12</td>
<td>14.33</td>
</tr>
<tr>
<td>17.</td>
<td>16</td>
<td>14.13</td>
</tr>
<tr>
<td>19.</td>
<td>16</td>
<td>16.04</td>
</tr>
<tr>
<td>15.</td>
<td>16</td>
<td>15.53</td>
</tr>
<tr>
<td>18.</td>
<td>16</td>
<td>14.32</td>
</tr>
</tbody>
</table>

Like the workers in Mauritius (5) we noticed that the row numbers of cobs of progeny differ from those of their parent and of their fellow progeny, and even that cobs on the same plant may differ in this character. Nevertheless we did not find any appreciable difference in the average weights of cobs of different row-number, though
though it is admitted that circumstances necessitated the use of somewhat small samples (25 cobs of each type).

We found no apparent correlation between number of rows per cob and shelling percentage as will be seen from the figures below, which were derived from weighings of all the cobs in the selected rows.

Table Showing Percentage of Grain to Cob in Cobs of Different Row—Number

<table>
<thead>
<tr>
<th>No. of Rows per cob</th>
<th>Average Percentage of grain to cob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>79.4%</td>
</tr>
<tr>
<td>14</td>
<td>80.0%</td>
</tr>
<tr>
<td>16</td>
<td>80.5%</td>
</tr>
<tr>
<td>18 and over</td>
<td>79.8%</td>
</tr>
</tbody>
</table>

So far as our experience has gone there seems to be no reason to favour plants bearing cobs of any special row—number, as this factor has no bearing upon yielding capacity.

It may be that the "splitting" of the progeny of a cob to give cobs of different row numbers may be an expression of the heterozygosity of the parent. We state the mean row number of the progeny cobs of the different strains that in future years, when purer strains have been obtained, it may be observed whether the means calculated come nearer the numbers of the parent cobs.

(d) Miscellaneous—

For observational work we think that closer spacing between plants than we employed would be an advantage, allowing of a more synoptic view of the variety; we suggest a spacing of 2 feet between the plants and 4 feet between the rows.

We think our successors would have a larger proportion of successes in selfing than we had if they selfed the earliest i.e., top cobs. We found that even if we could obtain enough pollen for later cobs, they rarely set seed. Selfing involves bagging the plant some days before the first silk appears. We would also suggest a trial
of the paper-tube method of selfing\(^{(24)}\) as an alternative to bagging.

Such materials as bags, sacks, labels, string, notice boards, methylated spirits (for sterilising hands) etc., should be ordered well in advance as there is not a large stock of such on the Farm, and there is usually delay in obtaining them from town. Labour need not be ordered from the Manager more than a day beforehand, except for very large operations.

Freshly harvested cobs should not be left in sacks for more than a day without airing, as they heat very quickly in this climate.

Drains to the main plots should be dug before sowing, as it is in the very earliest days that plants suffer from waterlogging.

II. Summary.

After some notes on the general position of maize culture in Trinidad, a reconnaissance of previous work on the improvement of maize is sketched in the introduction.

The outstanding feature about maize, to the plant breeder, is the fact that self-pollination usually results in loss of vigour, and all maize improvement schemes are centred in discounting this phenomenon. The various methods of maize improvement are discussed and criticised.

Criteria of selection of cobs and of growing plants are stated, and our own method of procedure, that of selection within self-fertilised lines, is described. A skeleton scheme has been drawn up for the guidance of our successors.

Yield data are given and interpreted as far as possible. Out of thirty lines started, nineteen have been selected for future work.

Other data, on matters which have a possible agricultural value
value, such as cob row-number are discussed, but no significant correlations with yield have been found.

Notes are appended on the trials of certain introduced American varieties, which were not an agricultural success; on some selfed selections handed on from last year, which were a complete failure; and on the insect and fungus pests of the year, which did not interfere at all seriously with experimentation.

III. References.


(3) Bruce, J.E., and Savile, A.H. Ear-to-Row Trial of Yields from Selected Maize Cobs. Thesis presented for Associateship of Imperial College, 1928.


(14) Kyle, C.H. and Stoneberg, H.F. Associations between number of kernel rows, productiveness and deleterious characters in corn.


(16) Jones, D.F. Dominance of Linked Factors. The productiveness of single and double first generation corn hybrids.

(17) Kisselbach, T.A. Corn Investigations.


(20) Hayes, H.K., and Garber R.J.

(21) A New Type of Indian Corn from China.

(22) Harland, S.C.

(23) A study of diversity in Egyptian Cotton.


The remaining nine ---00--- and the American varieties to be planted out in October 1924 in individual rows of a number of potrums. Selfing and rigorous selection should be carried on in these various rows.

All strains should be selfed until reasonable homozygous lines have been obtained, say in five or six generations. The object is to produce pure lines which shall be utilized for the production of high yielding varieties of maize. Whether this is accomplished by crossing or by direct selection of a pure line is a problem which later workers will have to solve in the light of fuller knowledge of this crop.
Inventory of seed on hand, May 1929.

The produce of 25 selected plants, numbered M.P.2901 to M.P.2925 is lying labelled in tins in the Field Office of the College. Together with this is a stock of seed of two American varieties, Reid Yellow Dent and Fred White.

Suggested Scheme of Procedure.

Six of these strains, M.P.2901, M.P.2902, M.P.2905, M.P.2908, M.P.2912 and M.P.2916 have been selfed and we suggest sowing these in mid-June of 1929, so that they can be harvested by next session's students when they arrive in October; this would involve selfing under the supervision of some responsible person at approximately 53 days after planting or say in the first half of August. Fifty plants each of the six strains to be sown, and ten plants per strain, chosen by the responsible person, to be selfed. We suggest that the two best of these selfed plants in each strain be retained by next session's students and be selfed by them, for the third time, early in 1930.

The remaining nineteen strains and the American varieties to be planted out in October 1929 in individual rows of a minimum of 25 plants. Selfing and rigorous selection should be carried on in these strains also.

All strains should be selfed until reasonable homozygosity has been obtained, say in five or six generations. The object is to produce pure lines which shall be utilized for the production of high yielding varieties of maize. Whether this is accomplished by crossing, or by synthesis, or by direct selection of a pure line is a problem which later workers will have to solve in the light of fuller knowledge of this crop.