

THE IMPROVEMENT OF PLANTING MATERIAL

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The subject of this paper is a novel one for a Tea Conference in Ceylon, though a certain amount has already been said upon the subject in lectures at District Planters' Association Meetings. It was inevitable that the improvement of the races of tea available for planting would one day take up a large proportion of the energies of the Physiology Department. Though in Ceylon attention to this subject has been long overdue, the experience gained from experimental and advisory work on more pressing problems during the first six years of the Department's history will, I believe, result in the selection work in progress here and elsewhere in the Island being based upon a surer foundation than if the subject had been taken up in 1930 to the exclusion of the more pressing problems affecting existing tea bushes. Nevertheless, it is daily becoming more apparent that substantial and immediate effort is required if measurable progress is to be made in producing economic results within the next decade or so.

What practical results are to be expected? In brief, selection work holds the possibilities of giving races or clones of tea bushes that will provide larger crops of better quality tea at reduced production costs owing to easier plucking, pruning, etc. This sounds Utopian perhaps, but we have this certainty — that, whatever the practical difficulties, the intelligent application of selection methods to such a heterogeneous and uncritically accepted mass of bushes as we have in Ceylon today cannot fail to work improvement. It is sometimes argued that because such and such a jât produced a very large yield in one field of one estate, tea of such capabilities needs no selection for use under other and less favourable environmental conditions. Such an argument leaves out all account of quality and of the fact that selection aims at the production of higher yield as the result of improving the intrinsic vigour and yielding capacity of the plants, thereby avoiding the expense of achieving this result by raising the fertility level by manuring.

In considering the subject the first point of interest is the material available on which selection can be carried out. The available range

has been augmented by small importations of seed from other countries and in particular recently of Indian tea jâts under special license for research. While my views upon the lack of uniformity and the haphazard planting of seed-bearers in Ceylon are now well known, even if not altogether accepted by those responsible, from the point of view of making radical improvements by strict selection the amazingly heterogeneous nature of the collections of bushes we style "tea" fields has certain advantages. In short, it means that we have existing in our fields the progeny resulting from the admixture of the major types of tea bush, "China" type, so-called "Manipuri" type and, probably to a much lesser extent, the large light leaved "Assam" type. These types I refer to are really rough divisions of the total range of variation and must not be regarded as botanical races when used in the sense usually used in planting circles. The Ceylon mixture is probably mainly of "Manipuri x China" origin, with greater or less amounts of China influence according to the age of the tea.

As might well be expected when the natural variation in characters of a botanical race is complicated and increased by groups of characters that have evolved in other races more or less geographically separated, there is no lack of variations in visible type. The leaf, of course, is the character most commonly given attention, and I would here like to stress that its size is often given an undue importance in assessing so-called "jât." While large and small leaved types of tea do undoubtedly occur, the comparison of leaf size must be made between leaves from trees of the same total age, age from pruning, cultural treatment, and growing in similar positions on the trees. When this is done, the size of the leaf can be a useful character, but when uncritically used it leads to such loose remarks as "the jât has improved since the field was pruned" or "since the field received extra manure." It is far better to confine one's self to observed facts — namely that the size of the leaf has increased. In fact the utmost caution is necessary to distinguish between local and temporary environmental effects on the one hand, and characters which are due to the inherited constitution of the particular plant under consideration on the other.

In general, tea in low-country areas is of more uniform type and often of higher jât than older tea up-country. This is due at least in part to the fact that many low-country bearers were grown from seed imported from India after some progress had been made in that country towards the production of more uniform bearers. Nevertheless, the forcing conditions of growth at low elevations tend to mask differences which are really present and so one comes across interesting cases of jâts considered uniform at low elevations which

are not so uniform up-country. I have observed this personally in the case of Indian jâts which greatly impressed me by their relative uniformity under plains conditions in Assam. The same jâts here, as far as seedling observations go, appear to exhibit a greater range of variation.

Since we cannot expect the desired uniformity of vigour or of composition in a visibly heterogeneous race, there is an obvious basis for the present policy, which I am glad to say is gaining numerous adherents, of eye selection of existing bearers for vigour and uniformity. But it must be plainly understood that this is but a temporary palliative to tide over the inevitably lengthy period before improved bearers become productive and displace older unimproved types from the market. There seems to be a prevalent idea, which I would like to express an opinion on in passing, that special sanctity attaches to seed from old bearers. Provided that the seed from young bearers is well filled and of adequate size, (i.e., a low number of seed to the pound) there is no justification for specially preferring that from old bearers. I personally would have no hesitation at all in using graded seed of the first year's crop of young *selected* bearers in preference to graded seed from old *unselected* or less carefully selected bearers. There is no reason, in my opinion, why the steadily increasing band of those who are carefully selecting individual trees for use as seed-bearers should not profit from their by no means negligible labours the first year seed is available from the new bearers.

No one will seriously deny that our bushes are very heterogeneous in appearance but we are interested in appearance only in so far as it indicates uniformity in yield and composition of the crop and the possibility of standardisation of cultural operations.

The yield and vigour of individual plants certainly do vary considerably. For example, the highest yield recorded on St. Coombs has been 0.73 lb. dry matter in 21 weeks, equivalent to, say, 5,000 lb. per acre per annum though of course such calculations have to be used cautiously. Lest this be though unusual, I may say that to my chagrin these values have been several times exceeded in selection work on commercial tea estates who have already undertaken this work! Again, high yields have been reported from clones in Java, in which country clones raised from selected mother trees are already in plucking and even in production as seed-bearers.

As regards the chemical composition of the crop in relation to the individual variations between bushes, investigations have not progressed far enough for it to be justifiable to do more than allude

to the Russian work showing variations in the tannin content of flush from different bushes and to the Java and North Indian conclusions that the characters of the teas made from different bushes vary considerably. I may, however, give an example of the indications that are being obtained at St. Coombs as a result of the use of the method of individual bush manufacture worked out by Mr. Lamb. The data are based on four comparable manufactures on each bush and must be regarded as preliminary in nature.

Bush A has given consistently a very coloury tea, normally of very common character, with bad infusions.

Bush B has given coloury liquors, of fair to poor quality, and greener infusions than the others.

Bush C has given liquors of useful colour, of fair to relatively very good quality, with relatively good infusions.

Bush D has given teas of fair colour, quality being fair to good, and infusions fair.

To quote from the report of Mr. Horne, to whom we are very greatly indebted in this connection, "Amplifying this report, the difference in the liquors of these samples is really extraordinary." "Discounting the abnormal conditions of manufacture which seem to give the liquors a peculiar bitter, strong character, the range of quality is from poor common low grown tea to quality that, as far as I could judge from these samples, would under normal conditions be considerably better than any teas at present being produced outside Nuwara Eliya."

It may be noted that the good tea referred to was made from shoots of tipping character produced after the rested bush had been pruned back. The tree in question has the additional interest that it is apparently a high yielder, and has a good habit of growth. It thus appears that it is possible that high yield and high quality may on occasion be found in the same bush.

This leads us to face up to the facts that every bush is *not* the equal of every other bush in economic value, and that a distinct possibility exists of bushes of greatly improved value being found in the future as the result of careful search among the existing bushes on your estates. I hope that in considering these points later, the uselessness of expecting to obtain substantial quality improvement by merely "thinning out a 'nice' area of tea and running the remaining bushes up as seed-bearers" will not be lost sight of. Real improvement involves prolonged work — I do not wish to disguise the fact. But those who are undertaking it cannot fail to be rewarded in some, though varying, degree.

For those sufficiently interested to undertake the work involved, a memorandum on selection is available on application to the Institute, and I hope that all those interested will attend the demonstration of selection for yield that will be given at St. Coombs tomorrow. It is sufficient to state now that a method of selection for yield which is as trouble-free and involves as little labour as possible has been devised. You will find the details in the sheets you have already received. (See Appendix).

The question of quality cannot be handled on estates at present. But if estates are willing to make-over material sufficient to plant up one of our series of clonal plots at St. Coombs, subject to the Institute's later opinion that the clone is worthy of such test, experimental manufactures will be carried out. But of course, if the clone proves of no great value as a yielder, this cannot be guaranteed, for what we want is yield and quality combined.

You will notice that I have been alluding to clones of tea. These, as you know, consist of plants propagated vegetatively and not by seed and are therefore series of replicas of the respective mother trees. To be able to increase the numbers of a given tree without the segregation of characters inseparable from reproduction by seed in such a heterogeneous crop as tea, is obviously of the greatest importance both for practical purposes and for the extent to which it facilitates the adequate testing or "proving" of selected trees. During the last two years a considerable amount of experience of different methods of vegetative propagation has been obtained, and it is now possible to propagate any selected bush with sufficient ease to allow both of the stricter examination of its yield and quality, and also of its multiplication for use as a component of a seed-bearer area consisting of several selected clones. For reasons which I do not propose to go into now, the formation of seed-bearer areas by the use of only one clone is not considered advisable in the present state of our knowledge. These methods of vegetative propagation, which are described in the other sheet circulated in connection with this lecture, can be seen tomorrow at St. Coombs. They have not yet been used for the planting of large areas of one clone, and the economic possibilities of the method have yet to be investigated in this direction.

As far as we can go at present the position may be summed up as follows: Satisfactory indications have been obtained that improvements in both yield and the quality of the produce may be obtained by the stringent selection of individual bushes from among our existing tea. While propagation by budding or by cuttings with a view to obtaining large areas of tea of one clone is still a matter for the future, working on the basis that on the average

like tends to beget like, it is recommended that carefully selected bushes be propagated to form new multi-clonal tested seed-bearer areas to replace the existing bearers in the Island. This policy must, from its nature, take very many years to fructify, but I consider that since supplying with improved material is obviously desirable, quite apart from any question of replanting, there is every reason that we should delay no longer in starting the work.

Those who visit us on the last Wednesday of any month can see the whole selection process, whose details I have deliberately not detained you with today. The Institute's personnel is insufficient to permit officers to visit individually the large numbers of estates that are applying for information but it does arrange to demonstrate all the essentials of the methods in routine use at St. Coombs to those who care to come and see them.

The Industry cannot hope to approach perfection in a year; almost certainly not for many years, for it is dealing with very difficult and abstruse problems in tackling selection work, but the Institute will do what it can to speed the process to the best of its ability, for it is only by the active co-operation of commercial interests and research that relatively speedy results may be obtained. But in so difficult a subject, I would ask you to remember those words of Hillaire Belloc:—

"Our brains are trained, our books are big,
But still we always fail
To answer why the Guinea-pig
Is born without a tail!"

DISCUSSION

MR. HELLING asked whether rootsuckers of convenient size could be taken from fields at the time of pruning and used as supplies with advantage.

DR. TUBBS said that while there was no objection to doing so he felt that the same percentage of success would not be achieved with rootsuckers as would be achieved with stumps. Rootsuckers needed to be lifted carefully with the bulk of their roots intact and could not be treated with the same severity as stumps. He did not feel that the process would be worth while unless the bushes from which the rootsuckers were removed had been selected for vigour, or other desirable characters.

MR. HELLING said that he had not actually had experience of the practice but felt that vigorous rootsuckers might be expected to make good supplies. He had observed that bushes affected with

Phloem necrosis frequently bore rootsuckers which had not been affected by the disease. He wished to know whether any experiments had been carried out on the subject.

DR. TUBBS said that he did not expect a rootsucker to form a potentially better bush than its mother tree, so that rootsuckers should only be taken from selected bushes. With regard to *Phloem necrosis* he suggested that there was a possibility of the disease being present in the rootsuckers but not yet exhibiting visible symptoms. Experiments had been carried out on layering and it had been found that layered branches had to be transplanted with considerable care if a good percentage of success were to be obtained. Layered branches could be regarded as similar to rootsuckers in this respect. An experiment was in progress which was designed to stimulate the production of large numbers of rootsuckers by the removal of the aerial portions of the bush. The results from this were not yet available.

THE CHAIRMAN requested that reference to *Phloem necrosis* be postponed until Dr. Gadd had given his paper.

MR. D. S. CAMERON asked whether any experiments had been carried out to determine whether different jâts varied in their resistance to Shot-hole borer.

DR. TUBBS said that a considerable amount of visual observation of low-country tea had convinced him that there was very little hope indeed that any existing jât would be found appreciably more resistant to Shot-hole borer than normal. The only hope of progress in this direction that he could hold out was that a few individual bushes might be discovered which were resistant to Shot-hole borer. This possibility had engaged his attention throughout his selection work and would not be lost sight of, but so far no bushes of this character had been discovered. If such a bush was found it would immediately receive active attention, as resistance to Shot-hole borer would undoubtedly be a very valuable character.

MR. KEILLER asked whether good tap root development could be expected from rooted cuttings.

DR. TUBBS stated that with regard to tea there has not been sufficient time to gather information on this point, but young plants grown from cuttings were growing as well as young plants raised from seed so that it could be assumed that the respective root systems were equally efficient. Work on other crops had been influenced to some extent by the prejudice of cultivators against the use of cuttings arising from the fear that the plants would exhibit inadequate root development in the lower soil layers. As far as he

knew further experience with all these crops had shown such a fear to be unfounded. In his experience the tap root did not go very deep in many Ceylon tea areas and he felt that there was some confusion of thought on the subject, since the rôle of the tap root could be taken over by any vigorous lateral or root which descended down to the level of the sub-soil. He personally considered that there was no reason to expect plants grown from cuttings to be less satisfactory in growth than those grown from seedlings.

MR. J. BYDE MARTIN asked if any estimate could be given of the time required to select a clone for yield and later for quality.

DR. TUBBS stated that a test for quality could not be carried out on clonal material supplied to St. Coombs until sufficient time had elapsed to allow the plants from the cuttings to come into production. He tentatively suggested 6 years from the rooting of the cuttings, but felt that this problem might possibly be later dealt with by budding on to established bushes. It was, however, too early to make any definite remarks on the subject.

MR. A. R. T. GIBBON asked whether dark leaf or light leaf bushes should be chosen when selecting desirable bushes for growth as seed-bearers.

DR. TUBBS said that since selection depended on the characters of individual bushes it was impossible to expect that there would be a consistent difference between dark and light leaf types and referred the questioner to an answer on this subject made in his lecture to the Dimbula Planters' Association earlier in the year which was reported in *The Tea Quarterly*. In India there appeared to be a prejudice in favour of light leaf types for manufacturing purposes. He had no experience of real light leaf jâts in Ceylon as he knew of no genuine light leaf areas in Ceylon. Most of the lighter jâts appeared to have been mixed with a dark leaf strain, in some cases possibly of China origin. In Java it appeared that some light leaf types were more susceptible to adverse environmental conditions than dark leaf types, but others were as hardy as the latter. He felt that for selection purposes one should be guided entirely by the vigour of the individual bush.

MR. GROVES asked how long it would take before selected bushes would produce seed suitable for growth for test of the character of the progeny. He asked that because he had seed bearers on his estate which were cut down as an experiment in 1932. In 1938 he found that the seed from these bearers gave a germination of only 65 per cent as against 95 per cent in the case of seed from unpruned bearers.

DR. TUBBS said that he was inclined to think that there was some other factor at work than the pruning of the seed-bearers, since large areas of seed-bearers had been pruned down and regrown in all tea-producing countries without detriment to the character of the seed. He asked what the reason was for cutting them down.

MR. GROVES said that they were cut down during the depression with a view to bringing them into plucking.

DR. TUBBS said that it was impossible to give a definite opinion without a more detailed knowledge of the bushes, but he did not consider that the pruning seven years ago was the real reason for poor germination. Well filled seed from plucking bushes pruned every 3 years germinated quite well. In practical work on estates this was forcibly brought to one's notice when tea was uprooted for replanting purposes, a vigorous growth of young seedlings frequently being found a few months later. For this reason he felt that some other factor than pruning was at work in the case mentioned by Mr. Groves. He would be willing to use well filled seed as soon as seed was produced for the purpose of testing progeny character.

MR. G. K. NEWTON asked whether the growth of bushes as seed-bearers which had been selected for high yield from amongst the bushes in a plucking field might not result in low yields of seed.

DR. TUBBS said that he was glad Mr. Newton had raised that question as it was one which required clarification. They were only interested in seed-bearers for the character of their progeny and he envisaged the possibility of high-yielding bushes of very desirable character for growth in plucking fields being found in some cases to be very shy fruiters. If such was the case it would be necessary to increase their areas of seed-bearers to give the desired quantity of seed. The fact that a desirable clone gave low yields of seed when grown as seed-bearers could not be regarded as a serious disadvantage of the clone. He did not consider the prior history of pruning and plucking would influence the later fruiting character of selected bushes.

MR. E. J. K. GARTHWAITE asked whether Dr. Tubbs had found that small leaf jâts rooted better than large leaf jâts.

DR. TUBBS stated that he was unable to give any general ruling in answer to the question, as he had found that bushes varied in their rooting capacity independently of their leaf characters.

MR. C. W. NEWTON said that he had always believed that the tap root was of considerable importance to the bush, but Dr. Tubbs had appeared to throw doubt on this. He asked what roots were of advantage to the bush if the tap root was of no advantage.

DR. TUBBS stated that he had not suggested that the tap root was of no advantage to the bush but had expressed his opinion that in the conditions affecting tea in plucking in Ceylon any lateral root which penetrated to an equal depth would compensate for the absence of the genuine tap root. Examination of uprooted bushes showed that in many cases it was difficult to determine whether the tap root was of more importance to the bush than vigorous adjacent lateral roots, while cases were frequently found where injury to the tap root had resulted in its functions being taken over by the lateral roots. That this was of very frequent occurrence indeed could be estimated from the fact that tea stumps made satisfactory bushes. In planting good size stumps the fine tip of the tap root was almost invariably broken or cut off before planting. Any roots which subsequently grew downwards would therefore be lateral roots. He considered that this demonstrated that genuine tap roots, *i.e.*, the developed primary seedling root, were not essential in any way to the growth of satisfactory bushes.

MR. I. L. CAMERON asked to what extent the vegetative progeny of high-yielding bushes could be expected to exhibit the same high-yielding characters as the mother trees.

DR. TUBBS said that in selection work it was always necessary to "prove" selected mother trees by vegetative propagation and further test. Experience in rubber had, he believed, shown that carefully selected mother trees were usually all found to be above the average in the yield of the vegetative progeny and that of such carefully selected mother trees a very few would be of exceptionally good character. He believed that the same would be found to be the case in tea. He did not wish to disguise the fact that disappointments were more frequent than successes when one was looking for clones of exceptional value but there was no doubt in his mind that strict primary selection would achieve a definite improvement in the average value of the progeny.

MR. GORDON PYPER asked whether Dr. Tubbs would recommend the planting as supplies of self-sown seedlings collected from among tea in plucking.

DR. TUBBS replied that he would not use such plants for ordinary supplying as it was better to select bushes of good character from which to obtain the seed rather than to continue the custom of planting any seedling which grew. He said that he felt very strongly that such self-sown seedlings should not, however, be discarded as they provided a very valuable source of plants for use in tea hedges as an anti-erosion method for the purely nominal cost of collecting them from the field.

APPENDIX

SELECTION FOR HIGH YIELDS

The basis of the method consists in locating those bushes possessing yield and vigour much above the average in spite of conditions of soil and of competition from surrounding bushes being normal as far as is known. This, when strictly applied, includes no bush situated on spoil earth or drain or roadsides and no bush having young bushes or vacancies in anyway adjacent to it — thus with normal planting only bushes having eight normally sized bushes adjacent to it are considered. Thus:—

X	X	X
X	O	X
X	X	X

These bushes may be picked out at any stage during the cycle.

(1). When field is in plucking.—Abnormally good bushes situated as above are picked out by eye, labelled and submitted to yield recording by the method described later. The assistance of intelligent pluckers is a considerable help in picking these out. Needless to say bushes possessing characters not considered desirable are not included no matter what their vigour.

(2). When field is due for pruning.—This is the method now in routine use on St. Coombs, owing to the ease with which the first preliminary choice of bushes is made. The pruners are instructed to leave about 5 per cent of the biggest bushes in the day's work unpruned, avoiding roadside and drainside bushes, and bushes with vacancies or young plants adjacent.

After the prunings have been lined the unpruned bushes may be inspected with relative ease and any bushes wrongly chosen by the pruners are pruned down. This work may be carried out by a conductor or kangany, so avoiding unnecessary work for the Superintendent. From the bushes that remain the best bushes up to the number it is intended to examine by yield records are marked by numbered labels costing in the neighbourhood of 10 to 15 cents a piece. If there is no immediate hurry the labelled bushes may be pruned and brought into plucking normally, and this is probably the best method for ordinary estate use. Recording is then started after the third tipping. If it is desired to speed up the process bushes may be cut across 9 inches above the old clean pruning cuts. It is very important to see that this height is maintained all over

the bush as pruners unused to this work are liable to prune bushes in such a way that the bushes are pruned with varying degrees of severity. At this elevation the cut-across bushes are plucked to one foliage leaf above the cut-across level six weeks after pruning. This is much easier than what would be normally considered practical on a tea estate at the elevation of 4,500 feet. During the first three rounds the "plucking" consists in removing *everything* above one leaf, even buds. This is to produce early production of laterals. After these three rounds are completed another 3 rounds of normal plucking are given and yield recording then commences.

Yield Recording.—The bushes are plucked weekly, a normal standard of plucking being maintained. In order to reduce the amount of weighing to a minimum, the following procedure is recommended: drill bags with tapes attached (procurable from the Wellawatte Spinning and Weaving Mills at 18-20 cents a piece) are numbered to correspond with the label numbers. At the commencement of the plucking of a group of fairly closely adjacent bushes, bags belonging to that group are laid on the surface of the bushes and the correspondence of bag numbers and label numbers checked. The flush is then inserted into the bag which is re-tied and despatched as convenient to the factory where drying is carried out.

Subject to the approval of the Insurance Co. concerned, it is recommended that the bags be laid out on the banks of tats next to the bulking chamber, where they should remain until the next plucking. After eight pluckings are done the bags are more thoroughly dried off in the middle of the ensuing week by placing on the trays of a stationary dryer. After drying the dry leaf is weighed in a tin of known weight on a postal balance weighing in eighths of an ounce. (The weight of the tin need not be subtracted for each record provided the same tin is always used).

The 25 per cent lowest yielders have their labels removed and are discarded from the selection experiment. After a further 8 pluckings a quarter of those that remain are discarded and so on until only those yielding at a rate equivalent to three times the yield of the field remain. These are then subjected to careful bush-to-bush comparison and the required number of the best and most suitable selected either for propagation and further tests or for direct use as "unproved" selected bearers.

Methods for further test and "proving" are based upon vegetative propagation and the actual design of the experiments and comparison of the results should be done in consultation with the Institute. The testing of high yielders for quality and character of teas produced can at present only be provided for at the Institute under conditions which will be referred to.