Selected Articles.

The Present Position of Bud-grafting.

THE following lecture on the "Present Position of Bud-grafting" by Col. F. Summers of the Rubber Research Scheme, Malaya, delivered at the Fourth Annual Conference of planters, held under the auspices of the Incorporated Society of Planters in Penang, is taken from the *Straits Echo*, August 16, 1927 :—

If we are to arrive at a correct definition of the present position of bud-grafting two things are essential at the outset.

First of all, we must be perfectly clear as to what is meant by bud-grafting; for a good deal of misunderstanding has arisen, and a large number of misconceived ideas have been created as a result of regarding the method as an end in itself and not as a means towards an end. The impression still largely prevails that bud-grafting from a high-yielding tree is bound to give extraordinary results on a plantation scale without any further precaution than a preliminary measurement of the yield of the mother tree over two or three years.

The truth of the matter is that bud-grafting is merely a simple method of plant manipulation which has been applied to woody trees, in temperate horticulture, for an unknown number of centuries. There is, however, with *Hevea* this radical difference. In horticulture generally the method is usually employed to improve the flowering or fruiting qualities of the scion, whereas in *Hevea* the object is the improvement of the yield of latex the production of which is generally held to be due to the activity of the vegetative portions of the plant, that is to say, the non-reproductive portions. On this account we must be careful in drawing analogies from the budding of fruit trees in temperate climates.

Java Investigations.

While at this point I might remind you that investigations in Java and Sumatra have established the very interesting fact that the trees produced by budding are often strikingly early and vigorous as regards flower and seed production. On this account alone the method must be considered an important feature of modern plantation technique.

In the second place we must have some well-understood standard by which we can measure any progress due to the method and assess its value in normal plantation practice. Such a standard is by no means easy to agree upon. At the present moment it appears the height of folly merely to claim for a method that it will lead to increased yields. Nevertheless, the sole claim made up to date by the most enthusiastic advocate of bud-grafting is that it is the best method for providing the planter with a uniform stand of high-yielding trees. Naturally, certain precautions are advised but we will not go into those at the moment. Unless there is a prospect therefor

of a greatly increased demand for rubber by the time new areas now being planted up will come into full bearing it does seem as though there were some justification, on economic grounds alone, for the attitude of conservatively-minded planters who refuse to regard bud-grafting seriously.

At the other end of the scale are those enthusiasts who see in bud-grafting a cure for all the ills which the rubber plantation suffers from and it is unlikely that the same standard of measurement will be accepted by both these schools of thought.

There are, however, one or two facts which will assist the man with an open mind who wishes to form his own conclusions from the evidence available uninfluenced by the leaders of either school of thought.

First of all we are all agreed that the modern scientifically managed plantation, with its unceasing struggle against such adverse factors as soil exhaustion, soil erosion, leaf, root and bark diseases; with its experimentally developed tapping system; with its constant aim at a high-grade product from the factory; and with its correctly managed staff and labour force is highly superior to the ordinary go-as-you-please small-holding. Secondly, I suppose we shall agree that these modern methods of estate management have been adopted because they are commercially sound and profitable. Thirdly, the aims of modern commercial horticultural practice are consistently directed towards the establishment of a plantation of uniformly high and good quality cropping trees as the surest method of increasing the difference between selling price and cost of production. Side by side goes a decrease of unskilled and an increase of skilled labour corresponding to the increased individual attention claimed by the trees.

No amount of labour expended upon the individual trees of an old fruit orchard will give a return commensurate with the time and money expended. A vigorous thinning out of the semi-derelicts must be practised together with their replacement by known and proved high or good quality yielders. I cannot too strongly emphasize the difference which would be made if all the trees on a plantation were uniformly high yielders so that the yield from a given area could be more or less closely forecasted. Trees could be tapped or rested much more systematically than at present. Imagine for example the convenience of knowing that 50 per cent. of your acreage, tapped on alternate days, would give approximately 50 per cent. of the total yield. Yet, judging from the results of recent research, this is no impracticable ideal.

A Fundamental Omission.

This brings me to what I consider has been a fundamental and serious omission in all discussions round the subject of bud-grafting. It has been tacitly assumed that the method has its usefulness only in the planting up of newly cleared areas. To my knowledge it has not been considered as an aid to the re-conditioning of areas of old rubber. The economics of the important subject have not been worked out as yet and in doing so the possibility of replacing worn out trees by established high yielders is certainly not one to be lost sight of.

It is often held that the agricultural research worker ought not to be concerned with the economic implications of his work. In an industrial research institute however one is not entitled to pursue a research which a short preliminary investigation would show to have no sign of improving the economic position of the industry. The fact that the Rubber Research Institute is contemplating work on bud-grafting indicates that the progress made up to date in this and other countries warrants further investigation of the method.

I assume that no person who is keenly interested in the rubber-planting industry is prepared either to extol or condemn any method, which seems to have potentialities for good, until he has made a critical examination of the evidence to be obtained from experimental work carried out on a plantation scale. This is the attitude which I myself take up and I am certain it is the same with most members of my audience.

Bud-grafting Methods.

In an endeavour to gain an indication of what has been accomplished by bud-grafting methods, I have recently inspected experiments and plantings, not only in Malaya, but also in Ceylon and Sumatra. It is with very great pleasure that, at this point, I can acknowledge the great kindness and cordial assistance which I have received throughout. Of one thing I am convinced, namely, that those persons who are trying out the method, whether research workers, or planters, are genuinely inspired with a desire to improve existing methods of plantation practice and that their efforts have met with a considerable degree of success.

The simplest thing at the outset seemed to be to take the objections to budded trees, which have been formulated during the last few years, and examine their significance in the light of the available evidence. These are I assume, very well known to all present.

In the first place, it has been stated that the junction between stock and scion is always likely to be a place of weakness so that bud-grafted areas will always be liable to abnormal wind damage through breakages at the union. From experience with budded and grafted fruit trees this is a result that would scarcely be expected, provided the operation was successfully carried out; rather the reverse. In the case of *Hevea* the union, so far as my experience goes, is very intimate and complete. One would expect this to be the case for the degree of compatibility between stock and scion must, from the nature of things, be very high. A longitudinal section through a bud-graft of *Hevea* three or four years old, shows no signs of weakness or incompleteness of union, while sections through younger bud-grafts show that the bud takes in quite a normal manner, and that subsequent development of the scion progress in precisely the same fashion as in an apple graft

This also applies to the healing process which results in the "Snag" being thrown off.

Further, I have seen bud-grafted areas which have been exposed to sudden storms and have examined damaged bud-grafted trees 3 to 5 years old. In no case have I seen a union give way while, in two cases, the damage to the trees was so great, showing that the strain must have been enormous, that the union could not have failed to give way had it been in any way weaker than the remaining length of the trunk.

I might sum up by the saying that personal observation leads me to conclude that there is no reason to suppose that the union is a place of weakness.

A second objection is lodged against the unsightliness of bud-grafted trees. In reality, so far as I can make out this only means that they are unlike the trees which we have grown up with and grown accustomed to. A similar objection might be made to every fruit tree in Great Britain for there the signs of grafting—especially of top and double working—can be detected in trees of a considerable age.

The "Elephant foot" of a bud-grafted *Hevea* tree does not interfere with the establishment of a good tapping surface, nor does the cylindrical

shape of the trunk. Moreover the swelling below the union becomes less pronounced as the tree grows older. In some cases it becomes almost unnoticeable at an early age. Moreover, no attempt has yet been made to ascertain whether the swelling cannot be eliminated or reduced by some modification of the method.

From an examination of the results of tapping bud-grafts it appears as though it would be advantageous to begin tapping at a considerably higher level than a seedling tree. Thus, even by tapping alternate days on a half spiral cut, and allowing for a bark renewal of at least six and a half years, it would not be necessary to approach the union near which it has been proved that the yield falls off considerably.

Thirdly, it has been stated that bud-grafts are likely to be less resistant or more susceptible to disease. I have seen no evidence for this and the general effect of grafting fruit trees is the reverse. In a few cases it has been shown that physiological diseases, for example, the mosaic disease of hops can be transmitted from the stock to the scion—if the latter is susceptible. In California, the English walnut is susceptible to root-rot, it is therefore never grown on its own roots but is grafted on to a black walnut stock which is resistant to root-rot. In such cases the precaution is always obvious; neither infected stocks nor susceptible scions need be utilised, for there are few planters who cannot recognise doubtful planting material. Susceptible stocks or buds of *Hevea* would therefore quickly become known if they existed and it would be a simple matter to avoid their use.

Longevity.

A fourth objection that has been advanced is that of a possible adverse effect of bud-grafting on the longevity of the resulting tree. It is held that this will have a span of life shorter than the allotted one for Hevea by the age of the mother tree from which the bud was taken. I can see no reason for this. The only analogy from fruit growing I am acquainted with is the shortening of life of dwarf bush and standard apples which is usually consequent on years of hard pruning and heavy cropping. In very many cases grafting has the effect of actually lengthening life. Reasoning from analogy is, of course, justifiable here.

Other Objections.

Other objections to the habit of growth or ridging of the bark and trunk only apply to a few clones and are by no means characteristic of bud-grafts as a whole. In fact, I can see no characteristic disadvantage of bud-grafts and the disadvantages that are apparent at present will no doubt be eliminated in time.

Assuming then that all is right with the method itself let us examine the position from the point of view of the plantation and see what benefit can be safely expected from the application of the method there. It is somewhat easier to indicate what cannot be guaranteed. For example, however good a mother tree may be, it can never be sufficient to rely on the yield records for a few years to give the necessary confidence for planting up a large area of bud-grafts directly from it. The quality of a tree as a mother-tree can only be determined accurately by the tapping of its buddings so that the first planting of a clone can only be regarded as a tapping trial. Even then the tapping should be carried on at least into the eighth year before a true indication can be gained of the yielding capacity of the trees. Conclusions have sometimes been drawn from the tapping results for a few months but this is never safe. A good yielder will remain a good one but a bud-graft which gives a low yield in its fourth or fifth year may improve out of all knowledge during the next two years.

[Col. Summers here referred to a paper by Mr. Grantham which had appeared in the *Planter* of July 1927 and said that he had expressed Mr. Grantham's figures in graphical form to illustrate his point. Col. Summers then explained certain charts on the board.]

These tapping trials will continue to be necessary until we have some method of identifying the high yielder at a much earlier stage. There is pressing need for research work on this point although I cannot say that definite results are bound to accrue. I have always been of opinion that an intensive study of the systematic characters of *Hevea* varieties and forms, combined with an investigation of their latex characters, would be the first line of attack and it was of the greatest interest recently to read in the Press that Hauser had laid the foundation of such work by investigating the hereditary character of latex particles. It is to be hoped that Hauser's work will stimulate activity in research along the above lines in every rubber research institution.

Common Mistakes.

While these difficulties of testing clones are present it is somewhat surprising to find that, in many plantations trials of bud-grafting, the commonest mistakes to be made are, first, losing all trace of the mother tree from which the bud-wood came and, secondly, trying out simultaneously too many clones. The amount of measuring, book-keeping, supervision and training of personnel involved in trying out four to six clones is, in my opinion, as much as the ordinary Estate staff can undertake if the results are to have the necessary reliability. Pedigree bud-wood is likely to be of considerable value in the future—material of uncertain ancestry is worse than valueless, it is positively dangerous where a perennial crop is concerned.

As you know, the tendency in other rubber-producing countries is to rely on a central, controlled Experiment Station for the supply of proved bud-wood. The success of this procedure is reflected by the large quantities requisitioned by and supplied to estates. Individual Estates are relieved of the responsibility and labour of trying out clones for themselves and can rely on the high quality of the material supplied.

It has been shown beyond doubt that better yields can be obtained from well-proved clones than from trees grown from what is commonly known as selected plantation seed. (In parenthesis I may remark that this seed is never selected in the genetical sense of the word so that the resulting trees must vary in quality to a very great extent.) I do not consider, however that the best method of tapping bud-grafted trees has yet been developed. As I mentioned earlier it has been shown beyond question that the yield falls when the cut approaches the union so that the obvious thing is to begin tapping at such a height that the most suitable period for bark renewal can be secured without the necessity for the panel to reach the region near the union.

What this height should be remains to be worked out and, of course, the problem will be complicated by the difficulty of tapping above a height of four feet. The best period for bark renewal also remains to be worked out.

Reciprocal Action.

One phase of the bud-grafting problem which urgently calls for investigation is the reciprocal action on one another of the stock and scion. I am apparently begging the question here for such action has not yet been indubitably demonstrated.

Hauser rightly calls this question the dark spot of the vegetative selection of *Hevea*, for, although he has not yet remarked any obvious effect of the stock on the yield of the scion, we must have the following questions settled as early as practicable. Has the stock any effect upon the production of the bud-grafting? Is the union such a disturbance of continuity that the yield must be adversely affected or has the stock the usual property of so increasing the vigour of the scion that the yield of the latter is correspondingly increased? There are ample grounds for suspecting some kind of influence for it has been recognised that the yield from a bud-graft may at times be surprisingly different from expectation. Again in a population of bud-grafts the yield generally shows high degree of uniformity but, now and again, considerable variation is encountered. Such variations are almost certainly not due to heredity and are probably due to some simple cause; but as the buddings are generally on unselected stocks there is always in the back-ground a possible unknown source of variation.

It is even quite possible that, eventually, we may have to select and propagate our stocks as carefully as our bud-wood. Research work in England has shown of recent years that, in the case of apple and plum stocks this is vital to success, although here again I ought to recall the danger of reasoning too closely from analogies.

I have also noticed one or two possible cases of bud-mutations or sports; where the sudden variation of a bud has produced a form quite distinct from that of the mother and capable of being multiplied and retaining its new form. A constant watch should be kept for these which might perchance prove to be of value.

In conclusion, it is frequently asserted that bud-grafting is but a temporary measure which will become superfluous as soon as surplus of seed are available from high-yielding pure lines. I think the up-to-date planter will always find it necessary to have the method at his command for a variety of purposes and most certainly until he is confident that the seed he is producing is pure and not contaminated by cross fertilisation from neighbouring low yielding trees.

Moreover it must be remembered that selection and breeding work on a perennial tree of unknown character like *Hevea* must be a long and laborious proceeding. The view to be taken is a long one and, while awaiting results, no one can afford to stand still. The best means to hand at the present time must be used, that is, careful and cautious application of the bud-grafting method.

My discourse on the present position of bud-grafting has, I am afraid, been somewhat lengthy and diffuse. It might have been summed up in the following sentences.

Bud-grafting is a horticultural operation which has been applied with an encouraging measure of success to the vegetative propagation of *Hevea*. The maximum benefit to the rubber growing industry cannot, however, be obtained without much further research directed towards the improvement of the method itself and the testing of the budded progeny. Much of this work can only be carried out efficiently at a central experiment station in the form of extensive trials under plantation conditions.

The large undertakings which have achieved such a striking measure of success by employing the method owe their success to keeping these principles in the foreground.