Breeding of Hevea

P.R. Wycherley, Rubber Research Institute of Malaya.

This is an abridged version of the review given by the Head of the Botany Division to the Natural Rubber Conference, 1968.

The average yield per acre in tapping on Malayan estates has risen from 450 lb in 1951 to 940 in 1967, during this period the percentage of the tapped acreage which was planted with selected materials rose from 24 to 80. These genetically improved trees, although many are still young and yet to reach their peak yields, have made the major contribution to increased yields. Improved methods of husbandry often modify by only a fraction the yield level determined by the planting material.

The average yields of unselected seedlings rarely exceeded 500 lb/acre/year even with good husbandry. The Rubber Restriction Scheme assumed average peak yields of 320 lb/acre/year. The mean yields per tapped acre for 1927–31 were about 460 lb/acre/year, when tapping was limited to the better areas as far as possible, however at the close of 1931 budded trees formed about half a percent of the area tapped and they made an increasing contribution thereafter. The published peak yield per acre during one year was 3855 lb by RRIM 600 in its oldest large scale trial. The yield of RRIM 600 in commercial plantings reported annually in the *Planters' Bulletin* has followed closely the trend in the trials, an average over the first seven years of tapping of 1500 lb/acre/year. Even RRIM 501, which is no longer recommended for planting because of its susceptibility to wind damage, has given an average yield from 200 commercial fields of more than 1000 lb/acre/year for the first seven years of tapping, although declining from 1470 to 1300 lb from the seventh to twelfth year due to wind damage. Perhaps these average yields should be reduced in the case of RRIM 501 to allow for those fields so severely damaged that they were taken out of tapping and replanted.

THE IMPACT OF REPLANTING

The slogans have been *'replant or die'*, *'more rubber at less cost'*. Replanting has been the means of replacing unprofitable material by high yielding trees. *More rubber* is needed to satisfy the growing demands of consumers, so that natural rubber will not lose its markets by limited and uncertain supply. The production of Malayan estates and that of the country as a whole have increased by 60% during the last 16 years, although the acreage has shrunk slightly following conversion of part to other crops. *Less cost* is essential to be competitive with the synthetic rival and to provide a greater margin for better living standards.

Economic studies show marked correlations between average yield per acre on estates and the profit margin and the cost of production.

At 400 lb/acre/year there is no profit margin, because the cost of production is 49 ct/lb, but at 1600 lb/acre/year the average profit margin is $500/acre and the cost of production is halved to 23 ct/lb.

The breeding and selection of clones and seedling families of *Hevea brasiliensis* which yield more and the implementation of these genetic improvements by replanting are the major factors contributing to the economic survival of the natural rubber industry today. However satisfactory the present situation may be, there are three major arguments against complacency and relaxation of effort.

Firstly progress has not been smooth and assured. Whether or not the losses due to wind damage in RRIM 501 have been exaggerated when assessed on a national scale, the withdrawal of this and other clones within a few years of recommendation for large scale planting is disturbing, because this was not due to displacement by much superior cultivars. Susceptibility to wind damage, or in some cases to leaf diseases, has been the main disadvantage discovered late in life of the selections rejected after recommendation. This indicated a breakdown in the large scale trial procedure, which was attributed in the case of trunk snap in RRIM 501 to the irregularities in testing due to the war, but this explanation does not hold true in more recent cases such as RRIM 605. Consequently the confidence of the planters in the recommendations has been shaken.

Secondly the improvements have taken a long time to achieve. Breeding and selection in *Hevea* began when the variation in yield was first studied about 55 years ago and took a great step forward into practical realisation with the development of budgrafting in 1917. Most clones recommended for large scale planting are primary selections or of the first generation. The generations of *Hevea* still march closely with the generations of the men who produced them, but this is not fast enough for the necessarily quickened pace, yet to go faster increases the risks of inadequate testing.

Finally the situation is by no means static. The world demand and potential consumption for rubber continue to grow, natural rubber production must keep pace with this or markets will be lost and synthetic production will expand to fill more than the gap and capture further markets from natural. The cost of production of synthetic is unlikely to rise. The need to raise living standards, incomes and revenue in Malaysia and other natural rubber producing countries, all in the developing category, also continues. The need for more rubber at less cost is as urgent as ever.

BREEDING AND SELECTION SCHEDULES

It is possible to multiply by budding the best plant in a population, therefore the prospects of rapid improvement are better for clones than for seedling families. Some inbreeding depression may result if a large

COPYRIGHT © MALAYSIAN RUBBER BOARD

proportion of selfing occurs in open pollination to produce seed garden progenies. Availability of these seedlings depends on the speculative advance planting of suitable seed gardens. There seems to be less flexibility in choice of tapping system for seedling families than for most clones. For these reasons, of which the first is the most important, official research institutes have concentrated on the breeding and selection of clones and given less attention to producing new seedling families. Private organisations have given equal or more weight to seedlings, perhaps because production and sale of seed is often a better commercial proposition than that of budwood. Improvement through clones will be discussed here. A typical schedule for the production of a new clone may be examined with a view to speeding up the process.

Nursery Testing of Seedlings

It was practice at the R.R.I.M. to take buds from all legitimate seedlings and to test all legitimate material in small scale clone trial as well as in legitimate seedling trial until 1960. Since then the increasing quantity of seed made available by improved hand pollination technique has made some reduction of the number tested in small scale trial necessary to meet the limitations in land and recording labour available. So far the selection for testing in small scale clone trial has been made largely on the criterion of the seedling's vigour of growth during the first year in the nursery, including rejection of apparent genetic yellows of plants very susceptible to leaf diseases. The selection effected in this way does not delay the programme much, because the clones can be budded onto stocks already established in the field in advance.

It is desirable to apply proportionately heavier selection in the nursery as larger families become available in order not to exceed the small scale trial facilities available. It is questionable if simple selection on vigour of the seedlings in the nursery, which is influenced by environmental conditions, is an adequate basis for strong selection, which is essentially prediction of those which will give the highest yields as clones when budded on a large scale. If selection is applied on characters such as branching habit of possible importance in reducing wind damage, the material must be grown in the nursery for more than one year and at wider spacings than used hitherto so that it can be assessed. Other characters such as latex vessel number are correlated with yield but are difficult to determine in very young material. Thus more reliable nursery testing will take more time and labour postponing small scale trial by a corresponding amount. Ideally if nursery testing could be sufficiently improved, it might replace small scale clone trial and enable large scale testing to proceed directly.

Small Scale Testing

The number of trees per clone in R.R.I.M. small scale clone trials has varied from 10 to 16 and many more genotypes could be tested as

seedlings without replication than as clones. If bred material is tested first as seedlings before small scale trial, the total period is increased. Only if seedling field trial is sufficiently reliable to pass directly to large scale trial may considerable land and perhaps some time be saved by elimination of small scale clone trials. The single seedling is at risk to pest, root diseases, lightning and various other accidents, also its performance may be influenced unpredictably by variable environmental factors, in particular the occurence of dry trees which is not random even in clonal plantings. Although there are correlations between the yield of individual seedlings and of the clones derived from them, the consensus of experience todate has been that these are inadequate and the performance of the seedling alone has been rejected as a substitute for small scale clone trial. The six RRIM SS clones were selected on seedling performance and all were failures in large scale trial compared with the corresponding RRIM 600 series clones selected on their results in small scale clone trial. Thus small scale field clone trial seems a necessary phase. Selection for large scale trial may be made after 3–5 years tapping in small scale clone trial, that is upto 10 years after budding.

Large Scale Trials

The degree of speculation in planting a clone on a large scale is reduced in proportion to the duration and extent of test it has undergone. The paradox is probably true that, when a clone has been so fully proven for unqualified recommendation, it will no longer be planted because it will yield less than the new minimum acceptable even if that is obtainable only from somewhat more recent and speculative selections. In the early years of clone selection there were numerous examples of recommendations for large scale commercial planting on the basis of small scale trial, which led to many disappointments. Therefore it is generally agreed that large scale clone trials are essential before recommendation for large scale planting, and many would prefer evidence of good performance in commercial practice before recommending clones for smallholders who may have their whole livelihood at stake. The proportion of clones selected for large scale testing, which are eventually recommended for large scale planting, has usually been 2 to 10 percent. This proportion justifies large scale testing.

The duration and extent of large scale testing depend on the characteristics to be proven. The object is to achieve a sustained yield at a higher level than hitherto on an economic tapping system after as short a period of immaturity as possible. Susceptibility to disease, especially leaf diseases, may lengthen the period of immaturity or reduce yields. Provided the trees are exposed to the leaf diseases under suitable conditions, excessive susceptibility can be detected quite early. Hitherto large scale trials have been replicated throughout the country to ensure that the clones are exposed to all diseases and climatic conditions, however, testing for susceptibility to leaf diseases could be carried out

in suitably located nurseries before acceptance for large scale trial. There might yet be need to replicate trials in order to determine their reaction to stem and in particular panel diseases or to die-back induced by drought.

Yields normally rise during the tapping of the first panel of virgin bark. The rise may be gradual or marked. Subsequently on the second panel the yield may rise further or fall away. Where the yield trend lies between these extremes can only be determined by trial. Yield trends from renewed bark can be reasonably well predicted from the trend on virgin bark, the quality of the renewal and the girth increment, in any case half the economic life is known on completion of the virgin bark cycle and recommendations cannot be delayed further. In practice clones are recommended for experimental scale planting when large scale trials are set up and may move into medium scale recommendation when the first 5 years of tapping in large scale trial are completed. Recommendation for large scale planting may follow after tapping the lower panels of virgin bark, i.e. 10 years tapping or 15 years from establishing large scale trials. During this period susceptibility to panel diseases and wind damage should have become evident.

Although there are differences in yield level between different trial sites due to soil fertility, amount of sunshine and degree of rain interference with tapping, which effect all clones similarly, the main changes in ranking or clonal interactions in performance with sites are due to variation in the prevalence of leaf diseases. If material susceptible to leaf diseases is eliminated from large scale trial by prior nursery tests, it may be unnecessary to replicate large scale trials. However, until there is a satisfactory explanation why the wind damage suffered by RRIM 605 while tapping the first panel of virgin bark was more severe in the younger 'Exchange' clones series of trials than in the older original RRIM 600 series clones trials, or a means of conducting or siting trials is devised which is sure to detect all wind susceptibility likely to be encountered under commercial conditions, it would be advisable to play safe by replication of large scale trials. Replication of large scale trials does not cost much more time and utilises land made available by estates, which would not be available for more speculative selections such as those going into small scale trial. The replication of large scale trials tests clones under a range of commercial conditions and guards against the selectionist forgetting any factor, also it provides more material on which to superimpose other tests such as variations in exploitation system.

FACTORS CORRELATED WITH YIELD

An understanding of the factors associated with yield may enable the choice of parents for large families and early selection to reduce the progenies to convenient size for field test, to be exercised so as to speed the production of improved clones.

Number of Latex Vessel Rings

No charcter shows more consistent correlation with yield than the number of latex vessel rings. Further the number of latex vessels differentiated each year appears to be a clonal characteristic largely independent of the vigour of growth.

There has undoubtedly been unconscious selection for increasing number of latex vessel rings in the history of *Hevea* yield improvement. More attention could be paid to this character in the selection of parents for large scale crosses. Selection in the nursery of plants for further trial by latex vessel ring count has been dismissed as impracticable because the number of rings in one- or even two-year-old trees is small for confident separation into classes, also there may be differences due perhaps to delayed germination or bud emergence. Budding out in the nursery to replicate material and growing the plants to adequate size for examination might delay field trial unduly.

However, these difficulties may be overcome by taking green buds from healthy seedlings to multiply the material at an early stage for nursery test. Significant correlations have been achieved between the yield per tree in large scale trial and the number of latex vessel rings in three year old nursery buddings. The number of latex vessel rings in the mature tree is highly significantly correlated with the number in the nursery buddings and (negatively) with the average distance apart of the inner latex vessels in the young plant. It is hoped that such simple anatomical observations may be made even in two-year-old material with adequate confidence for selection. The development of equipment to extract plants in large soil cores enables two year old nursery buddings to be transplanted into field trial without further loss of time after selection by such tests. Thus improved horticultural technique can come to the aid of the selectionist. The R.R.I.M. nursery has been equipped with overhead irrigation to promote uninterrupted rapid growth.

Vigour

In any planting, whether seedling or monoclone, there is a strong positive correlation between individual tree yields and their girths measured either before or after tapping. There is variation in early growth due to local environmental factors and to different genotypes of the trees themselves in seedling populations and possibly of the rootstocks in monoclone stands. These differences in early vigour persist and the mature trees display similar variation in girth, bark thickness, height, total mass, crown size, proportion of the canopy of the stand and amount of solar radiation received. These factors dependent on early growth determine a large proportion of the variation in yield. The nature of this relationship of yield to girth between trees within a stand of uniform age and husbandry is essentially the same

whether the trees are seedlings or buddings, it is only the range of variation which is usually much greater in seedlings than in buddings of one clone.

This correlation between yield and girth or early growth in seedlings is the basis for the strong selection on vigour in the nursery prior to small scale trial. It is also the basis of the suggestion that the yield of seedling stands could be improved by planting an original stand of many more trees than would be retained in the final mature stand, which would be achieved by heavy selective thinning on the basis of growth during immaturity. The latter has been tested in an experiment where the number of Tjir 1 monoclone seedlings originally planted ranged from 454 to 3632 per acre and were reduced to 154 trees per acre at opening for tapping by selection almost entirely on vigour. The tapping stand varied from 34 to 4% of the original stand. The least severe thinning gave a mean girth at opening just significantly less than those of the other treatments, which did not differ significantly among themselves. However, the mean yields per tree per tapping did not differ significantly among all treatments including the least severely thinned.

Moderate selective thinning of seedlings on immature vigour is advantageous in obtaining earlier tappability, more uniform stands and higher initial yields per acre and this should continue as normal plantation practice. However, heavy selection pressure of this nature has not resulted in any improvement in the average yield per tree and is therefore suspect as a means of reducing large seedling progenies to manageable proportions for further testing as clones. Preference should be given to clones which yield more than predicted by the general regression of yield on girth in selection from small scale trial for large scale test.

The relationship of mean yield to mean girth between clones each growing in monoclone plots in large scale trial is different from that beteen individual trees in one stand. The yield per acre during the first few years of tapping is strongly influenced by the number of tappable trees per acre and hence by the vigour of groth during immaturity. The mean yield per tree during the first years of tapping a clone trial is correlated with the girth at opening (immature vigour), this 'between clones' relationship is not nearly as marked as 'within clones' or that 'between seedlings'. At opening mean yield per tree and mean girth are positively correlated between clones, but as tapping proceeds this relationship disappears and eventually a negative correlation of yield with concurrent girth may emerge between clones. This results from the girth increment indicative of the growth of the whole tree being strongly negatively correlated with yield.

The rate of immature growth indicates the ability of the plant to assimilate, whether it is growing in competition with trees of the same clone or of different genotypes. The correlation of yield per tree with

girth at opening between clones persists for several years even when the correlation of concurrent yield and girth has been lost; this may indicate that part of the variation in yield per tree between clones may be attributed to the ability of the trees to assimilate as revealed by their immature vigour, since all monoclone plantings receive the same intensity of solar radiation. This effect is obscured in seedling plantings because differences in ability to assimilate and consequent variation in immature growth result in competition between the different genotypes and differences in size, proportion of the canopy and shares of the solar radiation received persist throughout the life of the stand.

Immature vigour is a desirable characteristic of clones to be planted on a large scale in monoclone stands because it reduces the unproductive period and influences early yields per acre. Therefore the least vigorous should be eliminated. However, stringent selection for early vigour is unlikely to enhance intrinsic yield per tree to a commensurate degree. Excessive selection for immature vigour may result in the elimination of all except the most leafy material, which may subsequently prove susceptible to wind damage.

Wind Damage

Certain forms of wind damage are associated with particular branching habits, especially a heavy fork arising at a narrow angle and rivaling the leader in growth. This characteristic can be detected quite early in the selection procedure and such clones could be eliminated then. An increasingly more common form of wind damage and certainly more difficult to prevent derives from the progressive development of a state of imbalance between the crown and its trunk which bears it resulting in trunk snap. Catastrophic damage of this nature was first observed in RRIM 501, a precocious high yielder. Although high yield and the heavy internal competition for assimilates reduces the size of the tree as a whole, girth increment — that is trunk growth — is relatively heavily depressed. In large scale trials there are high correlations between wind damage, yield per tree and girth increment (the last is negatively related to the other two) and weaker correlations between the number of trees lost and the mean girth of the clone at opening the trial (immature vigour). This may indicate as seems reasonable from field observation, that the more vigorous immature trees are leafier and have heavier crowns and as a result are more prone to wind damage if girth increment (growth) is retarded due to high yield. Thus uncritical selection of the most vigorous material may result in progressively greater susceptibility to wind damage.

The efficiency of assimilation depends not only on the amount of leaf, but also on its intrinsic efficiency per unit area and on the manner in which the foliage is born on the tree so that mutual shading is minimal. The efficiency of the foliage may be reduced by genetic yellowing or leaf diseases, but such plants are eliminated in any case. It is

not known if there is wide variation in the net assimilation rate of the foliage of different *Hevea* clones or if this can be detected easily during the early stages of selection. Plants with less foliage of greater efficiency would be preferred to the converse.

The shape of the crown in many clones is like a fan, but in a few it is more cone-shaped, PB 5/51 is the best known example. In the cone type less foliage is born high on the tree to catch the wind and there is probably less mutual shading and greater efficiency of assimilation than in a fan-shaped crown with a similar area of leaf and efficiency per unit area. The lower branches of the cone type arise at a wider angle, which seems more stable. PB 5/51 is a wind fast clone of moderate vigour. It probaly owes much of its windfastness to its crown shape, but perhaps also the lack of wind damage is partly due to the rather thin foliage in many cases owing to *Oidium*. Some cone-shaped clones suffer wind damage and some with fan-shaped crowns or 'telegraph poles' are free. Nevertheless theory and practice agree that branching angle, tree habit and crown form should be carefully studied and the existing evidence supports preference for wide angles of branch insertion and cone-shaped crowns in selection among progeny and in choice of parents, because branching habit seems to be heritable.

Leaf Diseases

Gloeosporium has been studied more than other leaf diseases in Malaya. The susceptibility to *Gloeosporium* attack and the period of immaturity are correlated. The heavier the incidence of *Gloeosporium* the more retarded the immature growth and the more depressed the early yields per acre dependent on the number of tappable trees. It is difficult to establish with confidence any relationship between yield per tree and clonal susceptibility to *Gloeosporium*, although higher yields are obtained from susceptible material when suitably crown budded, or in areas where the disease is not prevalent or they avoid it by wintering and refoliating before the wet period.

Most Malayan clones have been bred and selected in central Malaya where *Gloeosporium* is not quite so prevalent as in the south and *Oidium* is apparently less severe than in the north. When clones are tested on sites throughout the country, susceptibility to these diseases becomes more evident in the respective areas of prevalence. These effects are more pronounced when clones bred and selected in different regions are exchanged and tested in different countries.

Resistance to a leaf disease rapidly deteriorates if selection for other characters is pursued in the absence of the disease. Since resistance is a continuous variable and presumably polygenic, a chance combination of many genes for resistance is unlikely in the small proportion selected for yield, which agrees with practice. Therefore in breeding clones for higher yield in South East Asia, it would be advisable to choose parents

which between them already possess reasonable resistance to the two (or three) prevalent leaf diseases and to test the progeny against these diseases before large scale trial, or better still before small scale trial by nursery screening or perhaps a detached leaf test.

BREEDING METHOD

So far the method most used by the R.R.I.M. has been discussed, namely crossing by hand pollination the clones of the best performance in practice (phenotypic testing) in order to breed clones of the highest yield as soon as possible. There have been variations, some of which might be given greater weight in future.

Some of the older crosses can be analysed as incomplete diallels, a number of the more recent programmes have used the diallel design but the trials of the material produced are too young to provide yield data. Analysis of the earlier data suggested that the inheritance of vigour and yield in seedlings was strongly additive, it showed also that some of the potentially best crosses had never been made. If the inheritance of yield in clones when planted on a large scale also proves to be largely additive, which may prove to be so if the number of latex vessel rings is heritable in this way, then phenotypic selection of parents is justified. Although some of the potentially good crosses, which have been inadequately exploited according to this analysis, have been made again on a greater scale, it is doubtful if *Hevea* breeders can afford the extra phase of small scale trials necessary for genotypic testing before making crosses on a large scale.

It is not certain how many seedling generations elapsed between the introduction of *Hevea brasiliensis* to South East Asia in 1876 and the selection of the first clones from 1917 onward, but probably there were at least three generations. There have been upto three further generations of controlled breeding and selection since.

Some segregation of local populations probably occurred during the early seedling generations, the loss of resistance to leaf diseases which are not locally prevalent in the centres of clones selection indicates some genetic erosion. This has been corrected to a certain extent by the exchange of clones between countries in South East Asia. It is doubtful if the limit of yield improvement in material of Wickham origin has yet been reached provided recombination continues by crossing clones exchanged between countries. Such programmes still offer the best chance of enhancing the considerable level of yield already obtained during the next generation. However, it is agreed that genetic variability must be maintained and increased or a ceiling will be reached. Resistance to South American Leaf Blight must also be introduced and incorporated into *Hevea* in South East Asia as a defence against the possible introduction of the disease. Although slight resistance has been reported in PB 86 and RRIM 600, oriental selections are in general susceptible to

South American Leaf Blight, whether this is due to lack of resistance in the Wickham collection or subsequent loss by selection in the absence of the disease.

The Rubber Research Institute of Malaya has made several introductions of *Hevea* species from South American including clones selected for resistance to South American Leaf Blight. So far only limited use of these has been made in breeding work. The progeny of their crosses with high-yielding clones are intermediate in yield, that is less than acceptable commercial levels, therefore several generations must elapse before adequate upgrading is achieved. To cross even only the best of this material with a range of oriental clones and to repeat this for the best progeny is a very extensive programme and impractical to carry out by hand pollination, except for a limited number of specific crosses.

A programme based on open pollination requires that the parents should be available in convenient juxtaposition and coincident in flowering. Flower protection and improved technique have increased fruit yields from both hand and open pollination. In open pollination a specific cross to combine the attributes of two parents cannot always be guaranteed. There is evidence from trials of seed garden progenies that the proportion of selfing has variable effects on yield. Only a low proportion of resistant progeny have been obtained by screening against South American Leaf Blight seedlings raised from the seed of oriental parents in gardens planted with oriental and resistant clones.

Weighing these factors, it is probable that the most rapid advance in yield with satisfactory secondary characteristics including resistance to wind damage and to leaf diseases prevalent in the country concerned, will be achieved by legitimate crosses by hand pollination of parents with the particular characters desired, one or other should have high latex vessel number, fair vigour, good branching habit and resistance to *Gloeosporium* and *Oidium*, also to pink disease and *Phytophthora*. This hand pollination programme can be supplemented with illegitimate seed of good parents where conditions favour natural pollination by other good parents e.g. in modern polyclone seed gardens or at plot boundaries in clone trials. The new introductions can be preserved in seed gardens instead of conventional clone museums. These can be inter-bred by open pollination and the progeny planted in new seed gardens and after moderate selection the collection will be gradually upgraded. This pool of variability will provide a reservoir of genes available for incorporation through back-crossing by hand pollination if a critical disease situation arises. If the improvement process is successfully implemented, two or three generations will have elapsed, each conducted in seedling or small scale trial only, when the clones currently being bred by more conventional methods will have reached commercial planting, that is when yet further advances may be limited by genetic variability.

SUMMARY

The raising of yield levels by breeding and selection of *Hevea* has been a major contribution to maintaining natural rubber in a competitive position, although this has not been achieved without temporary setbacks or as rapidly as might have been wished. The schedule discussed assumed some 25 years from pollination to recommendation for large scale planting, to which the period of commercial immaturity must be added before the full impact of a new selection is appreciated. The problem is how to speed selection and at the same time to eliminate the risks of incomplete testing.

Improvements in nursery testing have been made or are in progress for better screening for resistance to leaf diseases, and the development of simple anatomical tests for latex vessel number. The replication of material in the nursery tests and the longer period of observation, which may be necessary, may increase the period before selection for small scale trial, but this can be kept to the minimum by improvements in horticultural technique: green budding, irrigation to pomote uninterrupted rapid growth and transplanting by means of large soil cores.

Selection of parents and among progenies should place more emphasis on latex vessel number and less on vigour during immaturity. Although lack of vigour during immaturity is a commercial disadvantage, very heavy selection for vigour does not lead to commensurate enhancement of yield per tree and may be associated with leafiness and heavy crowns which — with the retardation in girth increment consequent on high yields — may be responsible for the trend towards increasing wind susceptibility. High rates of assimilation, of which immature vigour is a measure, should be sought by selection for high net assimilation rate or for a tree habit which enhances efficiency without increasing the amount of foliage.

Resistance to leaf diseases is rapidly lost unless care is taken to prevent this. An unknown amount of genetical erosion has taken place in *Hevea* in South East Asia. Although this can be corrected temporarily by exchange of material between countries in the region, eventually the pool of genetic variability must be reinforced by imports of *Hevea* species from the neotropics. Some imports have been made, but more vigorous efforts must be made to put it through several breeding and selection cycles at the seedling or small scale trial level of replication of large popuations. In this way the variable low yielding material may be upgraded for incorporation in the main programmes.