PLANNING NEW CLEARINGS: RECENT EXPERIENCE AT ST COOMBS

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In a previous article (Elias, 1961) I covered most aspects of nursery management. In this paper I shall attempt to describe the field work involved in new clearings, namely—uprooting, rehabilitation, and replanting. Experience of replanting and new planting with clones is still rather limited and we continue to learn new things year by year. This article in no way pretends to be a general guide to the subject. There is so much variation in the individual problems dependent upon climate, soil, and terrain, that there can be few rules of general applicability.

I shall report experience gained at St Coombs in the last few years and stress the need for planning the field work involved from the beginning. It is necessary from the outset to consider the availability of labour and to decide on the clones to be planted and on planting distances. The economics of uprooting and replanting a particular area should be carefully studied.

Planning Uprooting

The planning essential from the beginning can be considered in three parts:

(*a*) the choice of area to be uprooted;
(*b*) the total acreage to be uprooted over a 5-year period;
(*c*) the area to be uprooted each year.

(*a*) The choice of area to be uprooted

Naturally we usually uproot the lowest-yielding uneconomic tea first, but it is useful to ask why the tea is low-yielding. If the land is exceedingly steep and if soil conditions are poor, it will be unwise to uproot and replant such areas without allowing longer periods of rehabilitation and arranging for improved methods of soil conservation (Pethiyagoda, 1958). On the other hand, if land with reasonably moderate slopes and average soil conditions is used and if high-yielding clonal material is planted, it is reasonable to expect that yields can easily be doubled in full bearing. Where patna land or virgin forest is available, this problem will not arise.

(*b*) The total acreage to be uprooted over a 5-year period

If this is planned ahead, all the financial implications can be taken into account. Consideration is given to the availability of labour, not only for the actual uprooting each year, but for the years of maintenance ahead, until each year's new planting is finally in bearing. In the area set aside for uprooting, "slaughter plucking" is resorted to immediately, and the increased crop helps to offset losses

brought about by each year's uprooting. Long-term planning also means that savings can be effected on items of revenue expenditure, as follows:—

(1) estate roads and paths—terracing can be avoided;
(2) drains—only superficial cleaning is necessary;
(3) boundaries and ravines—upkeep can be restricted;
(4) weeding—only selective weeding need be done;
(5) pruning—light "skiffing" or a periodic cut-across can be done;
(6) supplying tea—can be eliminated;
(7) mossing and ferning—can be discontinued;
(8) spraying against Blister Blight—less frequent rounds with smaller dosage rates can be carried out;
(9) shade trees—all high shade can be removed immediately; re-supplying of low shade will not be necessary;
(10) pests and diseases—spraying against mite attack is not necessary.

It should be remembered, however, that the dosage of artificial fertiliser needs to be increased if more leaf is removed and that normal applications of dolomite should continue (Tolhurst, 1959).

(*c*) THE AREA TO BE UPROOTED EACH YEAR

Immediate savings are effected on the lines mentioned in the preceding paragraph. The method of uprooting is decided upon as soon as the area is chosen. All suspect *Poria* patches are clearly marked out before uprooting commences and these areas receive special attention. Affected bushes are dug out and destroyed and each patch is cleaned out.

Although the *Poria* fungus is able to travel through the soil from an infection in a bush stump or woody roots, it is unable to exist in soil alone. Food supplies in *small* portions of roots left in the ground will therefore soon be exhausted by the fungus. It is advantageous to remove all cootch and illuk before uprooting operations commence.

Methods of Uprooting

Details are not available for clearing virgin forest; the machinery mentioned in subsequent paragraphs can be adapted for this type of work but costs will necessarily be slightly different.

The 'Trewhella' Mechanical Winch or Horse Grubber

This machine consists of a small but powerful motor, driving, by means of a belt, a series of gears directly coupled to a small drum with cable attachment. It is heavy and extremely difficult to move. If the machine is used on flat land, in light friable soil about 300 bushes can be uprooted in a day. In heavier soil and on steep land the moving parts tend to wear rapidly and the cost of upkeep and repairs becomes exorbitant. The cost of operating this machine involves petrol, an engine driver, a watchman and five labourers. The cost per acre of 5,000 bushes using this machine, worked out at Rs. 1,250/- including an item "rooting-out by hand" which is explained by the fact that certain types of bushes have little or no main stock and a grip by the winch cable is not possible. The initial outlay on machinery is not accounted for in the above cost per acre.

The Trewhella 'Hand' or 'Monkey' Grubber

This machine is a hand-operated machine capable of uprooting very large tea bushes. Four labourers are required to operate it. It is suitable for small-scale uprooting in areas where the slope of the land is not too steep. In thick tea on steep slopes, the operation is slowed down considerably. This machine would be far too slow for any large-scale uprooting unless several machines were used.

Uprooting by this method has been found to be expensive. The initial capital expenditure on equipment is small if only small-scale uprooting is required. Using four labourers and one Kangany, an average 88 bushes per day was uprooted. On the basis of 5,000 bushes per acre, the cost would be Rs. 735/50.

The 'Boughton' and 'Hesford Hercules' Power Winches

Both these machines require a tractor for the power take-off and have been used successfully on the most difficult terrain. The 'Boughton' power winch has one slight disadvantage in that the winch itself is a semi-permanent fitting to the tractor and takes considerable time to fit and remove in the event of the tractor being required for other work at short notice.

The 'Hesford Hercules' power winch is a trailer type and can be connected and disconnected in a few minutes. Any medium-sized tractor with a power take-off can be used with this winch. The winch has 300 ft of 5/8 in. diameter wire rope attached to the drum and this is used in conjunction with a pulley and two ground anchors which reduces the load. Small lengths of wire rope or chains with a hook and shackle attached to each are fastened round the bush and are in turn hooked on to the main length of wire rope. The machine is controlled by the tractor driver, the speed of the winch being regulated by the speed of the tractor engine. A safety clutch is fitted between the tractor and winch on the main power shaft. This can be pre-set to slip at a specified load. Altogether, ten labourers were required to operate this machine, uprooting between 300 and 350 bushes per day. Fewer of the larger roots were left in the ground when uprooting was done by this method. Soil disturbance increased to what could be a dangerous level in some types of soil. The cost per acre, not including initial outlay on the machine, worked out at Rs 475/-. This figure represents the cost of the operation when the winch was new. Subsequently, the cost of repairs and replacements was exceedingly high.

Hand uprooting

Uprooting by hand has been carried out successfully at St Coombs for the past two years, where a comparatively large programme of uprooting, for the size of the estate, has been undertaken each year. Close supervision is necessary when this method is resorted to, throughout the period of uprooting. Blocks of one to two acres were given out to family gangs for uprooting, followed by deep forking to 18 inches and planting of Guatemala grass at a minimum of 2 feet × 2 feet on the contour at a total cost of Rs. 850/- per acre. This cost included the uprooting of all shade tree stumps. All blocks were marked out before uprooting commenced. The contractor was responsible to the management throughout the rehabilitation period and, immediately prior to planting, for the final removal of all tea roots which were missed at the time of uprooting and the subsequent deep forking. This was clearly explained and understood at the time when the contracts were given.

Uprooted tree stumps, tea bushes and tea roots were not burned on the land itself, but on roads and paths, or in areas where new tea will not be planted. This should be done to avoid patches of heavy potash (alkaline) deposits on the land to be replanted. In fact, it was found that most of the uprooted tea and tree stumps were removed by the labour force for firewood. The surplus if any, can be burnt on roads or ravines or rolled down to the lower boundary of the uprooted area.

Soil Conservation

Immediately following the uprooting of the tea, it is vitally important to take steps to conserve the top soil from erosion. The top soil is loose after uprooting and the effect of even one heavy shower of rain can be most alarming. Wherever water collects on the land, drainage gulleys will rapidly form and the water flowing downhill will carry loose top soil away, often to a depth of several inches. Subsequent heavy falls of rain appear to be better absorbed into the ground; there is less run-off of water and less erosion (Tolhurst, 1958).

It cannot be too strongly stressed that soil conservation measures should be planned and applied promptly. With this in mind, it is desirable to commence uprooting at the top of a field, in contour strips of forty to fifty feet in width; the length is not important. As soon as each strip has been uprooted, deep-forked and levelled off, it should be planted up with *Guatemala* grass as soon as the weather permits. It has been found that closely-planted hedges of *Guatemala* grass at intervals of 20 feet, level and on the contour, will check surface run-off to a large extent. A light thatch of *Guatemala* grass loppings spread immediately above this hedge assists in checking erosion of the fine particles of top soil which will otherwise be washed away at the first shower of rain. The loss of top soil can be minimised by this method. As soon as possible, lateral drains 1 in 120 are cut, on the reverse slope or lock and spill, at intervals of approximately 40 feet, and sloping towards leader drains; sometimes this may not be possible until the full period of rehabilitation is over and until the land has consolidated after uprooting. If reverse slope drains are cut, the length of each pit should be 10 feet, sloping from 6 in. to 18 in. deep against the flow of water. Lock-and-spill drains could be cut with 1½ feet—2 feet bunds and pits 4 feet—5 feet long, 18 in. wide and 18 in. deep. The easiest method of putting in drains is to measure approximately 40 feet along a main leader drain putting in pegs as markers and then using a road tracer at 1 in 120 sloping upwards from the leader. The leader drains are built and stone-bunded all the way down in gulleys and ravines at suitable intervals. Boundary leader drains are cut on the reverse slope and large catchment pits provided wherever necessary.

Additional hedges of closely-planted Guatemala grass are put in above all road banks and in areas which are particularly steep. These hedges appear to grow more vigorously in comparison with the grass planted at 2 feet × 2 feet. The Ox-eye Daisy is an excellent cover crop for planting on all banks. Level stone terraces are also built wherever necessary. Field roads and paths are sloped towards the upper bank, and the side drains are stone-bunded at intervals of 10 to 15 feet, with silt traps every 25 feet.

Apart from erosion by rain, wind erosion is an important factor to be considered. If the loose top soil dries out in the hot sun, wind erosion of the finer soil particles can be appreciable. Little can be done until some form of cover has been established on the ground. This will be provided largely by the grass thatch from periodical loppings. The provision of wind breaks in the form of hedges of *Acacia*, either *elata*, *pruinosa* or *decurrens* species, across the path of the south-west or north-east winds, planted one year before uprooting commences, may be practicable.

This can be done by uprooting strips of the old tea, 3 feet wide, at intervals of 40 to 50 feet and establishing the wind belts earlier on. The benefits will be two-fold, namely, minimising wind erosion just after uprooting and providing protection against wind to the newly-planted tea later on. *Sesbania cinerescens* is a fast growing species and suitable for planting as soon as the land is ready for planting. Thinning-out can be done from time to time as the tea plants become established.

At St Coombs the latest approach to the shade-cum-wind-belt question has been taken up in the following manner. Firstly, the land is carefully studied, if possible from the opposite hill, and an assessment is made of the badly windswept areas. Sometimes it will be necessary to treat each block of land separately. Wind belts are then planted across the path of the S.W./N.E. winds, say 100 feet apart running in a N.W. to S.E. direction. Species of *Acacia* are being tried out as wind belts, *e.g. elata, pruinosa* and *decurrens*. It will remain to be seen whether any one of these species will provide the answer to the search now being made for a suitable tree for use as a wind-break.

The rows or paths cleared for the wind-breaks are 3 feet wide and are not planted with tea. There is evidence to support the contention that competition from closely planted shade trees retards the growth of the tea plants in the immediate vicinity. The *Acacia* species are planted three feet apart in the row to begin with. Later, thinning-out can be done to six feet by removing every alternate tree.

Tea, planted three feet apart to begin with, is also being tried as a wind belt in this clearing. If necessary, thinning-out can later be done to six feet. Where tea plants are being used, every available clone is being planted in threes, so that eventually if thinning-out becomes necessary, a pair of each clone will remain. It is envisaged that these trees, when fully grown, could supply material for plant breeding work. Cross-pollination by hand could be carried out on the spot. Apart from the wind-breaks which have been placed at intervals of 100 feet, three rows of shade, running in the same direction as the wind breaks, have been spaced between at 25 feet intervals. The middle of the three rows has been planted up with *Grevillea robusta* spaced at 12 feet in the row, to be thinned out to 24 feet and perhaps 48 feet later. The other two rows are being planted up with dadap or the three *Acacia* species mentioned above.

Soil Rehabilitation

For many years, rehabilitation of the soil after uprooting tea, by means of planting Guatemala grass for eighteen months or two years, has been accepted by the industry with little question.

Guatemala grass planted as a rehabilitation crop minimises the incidence of weed growth, prevents soil erosion almost entirely as soon as it becomes established, and is believed to free the soil of eelworm infestation if the land is kept free of weeds (Hutchinson, 1962).

It provides a thick cover of shade to the ground, breaks the wind to some advantage for adjoining fields of tea and also provides a thick, long-lasting material for thatching the ground.

Another aspect is that it is very popular with labourers as a fodder grass for cattle! This is decidely a disadvantage from the planters' point of view.

At St Coombs the accepted period of soil rehabilitation is eighteen months. During this period the grass is lopped five times; one light lopping 2 to 3 months

after planting to induce spread, three medium loppings at 21 in. thereafter, and then a hard lopping before the grass is finally cut off at ground level about 3 months before planting is due to commence. Therefore the grass is manured four times, usually a week to ten days after each lopping and the manure is broadcast over the ground at the rates given below (Tolhurst and Portsmouth, 1956).

Sulphate of Ammonia	5 parts by weight
Superphosphate	3 parts by weight
Muriate of Potash 60%	2 parts by weight

At St Coombs the first application is at 3 cwt per acre; the second, third and fourth applications at 4 cwt per acre and 4-5 cwt is applied after the last hard lopping.

As a matter of interest, several well-grown Guatemala plants were dug up one year after planting to ascertain how deep the root system had penetrated into the soil. The results were as follows:—

Average weight of each plant—28 lb green material
Average weight of stems and shoots of each plant—20 lb
Average weight of the roots of each plant—5 lb
Average depth of root penetration—3 feet
Average spread over ground of each plant (top)—5 feet
Average spread below ground of the lateral roots—8 feet

The approximate weight of green material available from one acre of well-grown Guatemala grass planted 2 feet × 2 feet is 80,000 lb per lopping. This is equal to roughly 9 tons of dry weight per lopping. Calculated at four loppings per 18 months, the first light lopping being discounted, this is 140 tons green weight or 36 tons dry weight.

The roots of Guatemala grass provide abundant organic matter and improve soil structure (*see* Tolhurst, 1959a). A mass of matted roots was found in the top six inches of soil. The total weight is approximately 22 tons per acre. It is important that the operation of cutting the grass to ground level is carried out in January. The dry weather helps to kill off any root suckers. If this operation is delayed, considerable additional expenditure is incurred in controlling fresh shoots which appear from time to time and grow vigorously.

It is possible that the period of rehabilitation could be reduced to one year at St Coombs and on some other estates. One year is the minimum stipulated in the Tea Replanting Subsidy Scheme.

Rehabilitation of any kind is expensive. For one thing, it postpones the time when new tea will come into bearing, and if ways could be found to shorten this period of waiting this would be of great value to the industry. We ought to be constantly searching for new methods through practical application on estates. Practical observations made in the field, however unimportant they may seem at first sight, will often help scientists to reduce the length of their investigations.

Factors Affecting Planting Distance

We have made considerable progress in recent years with replanting and new planting of tea, using clonal plants on the contour. From the experience gained, it is now felt that the subject of planting distances in the row and between rows ought to be re-examined carefully, taking into account the type of clone that is to

be planted (*see* Easteal, 1961). Matters of importance to be considered are quality, rooting habits, vigour, spreading habits and the density of the plucking table, and other aspects which have an indirect bearing on spacing such as soil fertility, soil conservation and manuring. The advantages of closer planting, *i.e.* 4, 6, 8 or 12 inches apart in the row and 4 to 5 feet between rows, are often discussed, but the spacing between the rows may well have to be increased to enable field operations such as plucking, applications of fertilizer and spraying to be carried out without undue difficulty. The initial cost of planting will cause an overall increase in costs, but savings will be effected during the maintenance period and subsequently through the years on items such as weeding, resupplying and draining.

Methods of bringing-into-bearing can be modified by bending *only* between rows, but it is more than likely that this practice can be completely eliminated. Methods of bringing-into-bearing will largely depend on the type of clone planted, *i.e.* whether it is a vigorous spreading clone or an upright clone (Visser and Tillekeratne, 1958). Pruning methods will have to be modified. Side-pruning might have to be resorted to if the bushes have grown too rapidly between the rows. Plucking of side branches to check spread can be done every plucking round if necessary. Thumb-nail pruning in the nursery and subsequently in the field throughout the first year has given excellent results so far. This method does away with bending entirely and the plant is brought into bearing by removing a bud and two leaves at a height not exceeding 14 inches during the first year's growth.

The slope of the field has to be taken into account when calculating the distance between rows. The steeper the slope the closer is the projected planting distance between the rows. Some examples of the effects of planting density at St Coombs are interesting. (1) In a clearing planted in 1954 (planting distance 4 feet × 2 feet, approximately 5,000 bushes per acre) of Clone TRI 2024, considerable difficulty has been experienced in carrying out normal field operations, due entirely to the vigorous spread of the side branches. Pluckers find it impossible to walk between the rows of tea and never carry their plucking baskets when plucking in this field. It is an endless struggle to get through. Should the periphery and centre of a tea bush be taken into account when the actual spacing is being decided upon? How much removal of the periphery can be undertaken from time to time, if closer planting is done, without affecting yield? (2) In a block of Clone TRI 777 planted in the same year, under similar conditions, these difficulties have not been experienced at all. (3) In a field of seedling tea (Field No. 13—21 acres) planted in 1937, hedges of tea were planted 4 in. apart in the row above all field roads and drains. Following pruning, when all bushes received similar treatment, the hedges were ready for tipping four weeks earlier than the tea bushes planted 4 feet × 2 feet. These hedges form a continuous sheet of tea after tipping and the closely planted lower stems effectively conserve soil by holding up soil washed down through the years.

Topiary (Wedge) Pruning and Plucking

Small-scale experiments on topiary (wedge) pruning (Roe, 1961) followed by topiary plucking, have been carried out. If the usual pruning heights are maintained during pruning, considerable lowering of the side branches, by cutting back, is necessary in order to train the bushes into a wedge form.

Other methods which can be adopted are (*a*) normal slope pruning to begin with, afterwards training the bushes into a mild wedge form at the tipping stage so that the slope of each side of the bush is moderate and the side branches of each bush will trail into the other; (*b*) normal slope pruning to begin with, training the

bushes into a "Chinese pagoda" shape at the tipping stage so that the slope of each side of the bush is steep in the centre and the side branches still trail into each other.

Lining and planting operations

From experience of the weather at St Coombs during the past two years, it does not appear to be safe to plant earlier than late June. Lining should therefore commence late in April or early May. The method adopted here is as follows:—

Lateral drains sloping 1 in 120 make excellent master rows (raja nerras) for the purpose of lining. Where large acreages are involved, two or three gangs of labourers are employed with lining ropes at least 100 feet long. Assuming that the planting distance between the rows is to be 4 feet, the actual distance between drains at three or four points is measured. When this is ascertained, one can decide how many rows will fit in. Generally it is best to put the first row below or above a drain at 1 ft to 2 ft from the edge, and then measure out 4 foot intervals. If this is done the short rows will be placed immediately above or below a drain and *not* in the middle.

On the other hand, if the block of land being planted is shaped differently, short rows in the middle as well as at the bottom become inevitable. This will depend on the terrain.

The conclusion reached, therefore, is that each piece of land has to be handled on its merits.

Perhaps for the first time on any large-scale planting (15 acres annually at St Coombs) a planting distance of 4 feet × 1½ feet is being used. The clones being used are Drayton 1 and 95, TRI 2024 and 2025. After lining and holing has been completed, one ounce of artificial fertiliser may be mixed into each planting hole, but this operation could be postponed until after planting.

All plants produced at St Coombs have been polythene bag plants stapled at the bottom twice and with holes punched on the sides with an office punch. The plants are transported by tractor or lorry in wooden boxes and carried from central areas to the field.

Labourers with some experience of planting are engaged. The soil close to each planting hole is loosened and the hole cleared of any debris which may have collected.

It has been found that peeling lower two-thirds of the polythene bag off and leaving the top third on prevents complete disintegration of the soil in the cylinder. If the polythene bag is completely removed it has been observed that the soil disintegrates and root disturbance and loss are quite considerable.

Immediately after planting, prunings are used to counteract the ill-effects of the wind blowing the young plants about. This method has been most convenient if pegging is done later; pegs can be obtained from these prunings.

And finally, after planting has been completed, all lateral drains are cleaned out once again, the remaining thatch is spread evenly over the ground and the clearing is tidied up generally.

Summary

1. The choice of areas for replanting should be carefully considered, particularly if the areas are low yielding.

2. Planning ahead is equally necessary, because so many factors are involved.

3. It is important to decide which method of uprooting to adopt and to make early provision for machines and labour.

4. The vital importance of taking steps to conserve soil at all stages of the operation cannot be stressed too strongly. Through soil we hold the key to ultimate success or failure.

5. The period of rehabilitation should depend on the condition of the uprooted area, or the area to be planted (if patna or virgin forest is involved). Naturally, the fertility and depth of the soil must be taken into account as also must the occurrence of gravel soils overlying a clay stratum, steep land, eroded land, and land with a high water-table.

6. Regular lopping and manuring of the Guatemala grass during the period of rehabilitation should be done, if maximum benefit is to be derived.

7. The selection of clones for planting should take into account particular clonal characteristics and factors such as quality, resistance or tolerance to eelworm, and to Blister Blight.

8. Planting distances will naturally depend on whether the clones selected for planting are known to be 'spreaders' or upright growers.

9. The method of bringing plants into bearing in the field will depend on treatment of the plants in the Nursery (thumb-nail pruning) and on planting density in the field. In a clearing planted 4 feet × 1½ feet with TRI 2024 or TRI 2025, assuming spread has been induced in the nursery by thumb-nail pruning, bending will not be necessary. If regular removal of a bud and two leaves continues in the field, sufficient spread can be obtained. On the other hand, with an upright clone (either DT 1 or DT 95), if the planting density is 4½ feet × 2 feet and if no spread has been induced in the nursery by thumb-nail pruning, bending will have to be done in the field to obtain spread.

10. The polythene cylinder is here to stay and there is no question about the efficient function it performs in the nursery. The advantages of using the polythene cylinder are numerous. When placing plants in the planting hole it is advisable to tear away only the bottom two-thirds of the bag. In this way disintegration of the soil and of roots in the bag is minimised.

11. Adequate measures should be taken to ensure that wind damage to young plants is minimised. Wind-breaks of various species (including tea) can be tried and will, I am sure, help considerably towards achieving the desired result.

12. The importance of regular and frequent applications of artificial fertilizer cannot be stressed too much. "Little and often" is a good motto to remember.

13. Finally, the success or failure of our work in the nursery and in the field in respect of new clearings will depend largely on the degree of attention we give to detail. Considering that we what plant today must last a lot longer than our lifetime, this work surely merits very special attention.

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APPENDIX

A PROGRAMME FOR 18 MONTHS REHABILITATION IN THE S.W. MONSOON ZONE

(Numbers in brackets indicate the months from starting)

By end of September	...	Uprooting to be completed.
By end of October	...	Guatemala grass to be planted (1).
November-December	...	First application Guatemala grass manure @ 2 to 3 cwt per acre. Very light lopping to induce spread (2 & 3).
Between January & November	...	Two to three loppings cut 18 in. above ground level to be spread over land. Two to three applications of Guatemala grass mixture @ 3 to 4 cwt per acre after each lopping (4 to 14).
By end December	...	Final hard lopping (4 in.-6 in.) above ground level. Heavy thatch with all available material from outside, covering ground completely in preparation for drought (15).
During March	...	Lining, holing, after cutting Guatemala grass to ground level (18).
By 20th May	...	Planting to commence* (20).
By end June, latest mid July	...	Planting to be completed (21 & 22).

(1 to 18)=*months of rehabilitation.*
(19 to 22)=*months of planting.*

* Late June is advisable at St Coombs

NURSERY PROGRAMME

Between January & March	...	Cuttings to be put out in nursery beds. These will be 13 to 15 months old at time of planting (1)/(3).
Between June & December	...	Regular fornightly applications of manure (6)/(12).
Between August & December	...	Gradual thinning out of shade (8)/(12).
December	...	Take plants down to two mature leaves to begin spread in nursery (12).
February	...	Final application of manure, preferably T. 175 water on (14).
20th May / June / Mid July	...	Planting out in field (17, 18 & 19).