YIELD IN RELATION TO BUSH GROWTH

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There is a very general impression that all is not well with the appearance of a great deal of tea in Ceylon, particularly in up-country districts. Bushes, it is said, look thin and played out and the number of such enfeebled specimens appears to be increasing. Intimations of this general unease reach the Tea Research Institute in several forms, three of which are of quite regular occurrence. It is sometimes suggested that after seventy or eighty years of tea cultivation on the same soils, there may be deficiencies in the so-called trace elements, and that the general debility of tea is due to the virtual exhaustion of the soil of these elements by reason of erosion and the constant drain on reserves. A second attempted explanation is that the bushes are suffering from the restrictions in manuring that have been imposed during the last six or seven years of rationing. Thirdly, there is increased talk attributing defoliation to Blister Blight. I do not myself think that any of these hypotheses, singly or in combination, can satisfactorily account for the quite evident deterioration that is remarked, and in order to clear the way for what I have to say later, I had better quite briefly say why.

The suspicion that trace element deficiencies are responsible is a not unnatural one, but at present there are two difficulties about it. Such deficiencies are generally accompanied by very striking symptoms in the bush other than an unthrifty condition. Tea yellows due to a sulphur deficiency for instance is, according to published accounts, quite unmistakable. Moreover, deficiencies are primarily due to peculiarities of geological constitution in the rocks from which soils are derived, and are in actual experience observed over much larger areas, even in the first stages, than are noticeable here. As regards Blister Blight, Dr. Gadd has indicated that the older leaves of the bush are not susceptible to the fungus, and the weakness in foliage density which a bad attack of blight reveals is, as far as observation goes, a weakness which quite definitely antidates

the disease. The disease in other words merely reveals the nakedness of the land. The third explanation does not satisfy me either, except to the extent that during the war we have been producing crops of the same order as before the war on very much less manure. Without a shadow of doubt there has been a great deal of hard plucking in order to achieve this result.

Two of these proferred explanations assume that the conditions can be rectified by putting something into the ground. My own conviction is that, without in the least minimizing the importance of adequate nutrition, the present state of affairs is the natural consequence of harder pruning and plucking that, according to my observations, has becomes general in the last decade. Dr. Gadd has spoken about the importance of the leaf as the manufactory of the food of the bushes. He has quoted figures to remind you of how little of the tissues of the bush is composed of those elements that are derived from the soil. From my rather different standpoint I want to emphasize the same points : that what is taken off the bush as crop is intimately related to what is left on as foliage. Obviously, if crop is not taken, the foliage category benefits and vice versa. It is necessary that a balance should be struck between the two. It is salutary that this concern for the appearance of the bush should be widespread for, in my opinion, it is long overdue. In what follows I am going to draw attention to a few of the pointers from the experiments of the Institute which show the particular importance of considering the bush as a whole when cropping capacity is under discussion. If I may make a personal assessment of the permanent contribution made by the experiments it has been my privilege to carry out here, it is not that the experiments have shown that this or that manure is more or less beneficial : it is the insight such experiments have given into the essential oneness of the bush is all its aspects.

First of all then, what evidence is there of the kind of balance that is presumed to exist between the foliage-leaf cover and the harvested crop ? I do not wish to put more weight on purely empiric data than they will support, but my justification for quoting what data we have is that it is better than none at all, and I think that it may serve to emphasize the point I wish to make. We have followed during four cycles at St. Coombs the relationship between crop, foliage and pruning wood. We have also made sample estimates of the crop-foliage correlation on five other estates in widely different districts and climates, and with pruning cycles from 2 to 5 years. It is relevant to remark that these data were compiled under the normally accepted conditions of plucking carefully to a full-leaf. If we take the total of crop plus foliage leaf and express the foliage leaf as a percentage of this we find that the lowest values observed in the series was 46 per cent, and the average of all data was 54 per cent. If single leaf plucking represents a desirable norm, then we shall not be far out if we say that to maintain that norm at least as much leaf must remain on the bush at the time of pruning as has been garnered in crop. When therefore we see the ghostly appearance of many bushes at the end of the cycle, we may well assume that they have contributed little to the yield per acre unless they have been ruthlessly plucked. If they have, then the proportion of leaf to crop will have fallen. We have data to show that by fish-leaf plucking the proportions can be altered from 50 leaf to 50 crop, to 20 leaf and 80 crop. But by doing so the pruning wood

has been diminished by half and the total growth of crop, foliage and wood by one third. This decrease in total growth has been effected without any change in manure, so it is unlikely that further manuring will provide the remedy, and extremely likely that if the mutilation of the bush continues, the crop will suffer.

That brings me to the second pointer which has to do with the immediate effect of manuring on crop. There is a very persistent belief that it is possible to force crop with manure to the ultimate detriment of the bush. Correspondents with the Institute write of the lasting effect of certain manures and the flash-in-the-pan effects of others. If there is one thing of which I am certain after my 21 years connection with tea, it is that the results of an individual application of manure cannot be assessed, either in the field, or in the crop book, on a short term basis: there are too many variable factors at play. The experimental results of the Institute's manurial trials show with remarkable consistency that if you secure an increase of crop as a result of increased manurial application, then you increase the foliage leaves too to a corresponding degree. It would indeed be strange if it were otherwise. The plant is an organism whose growth processes are integrated one with another. I am not very fond of anthropomorphic analogies; they are usually wrong when applied to plants. But nobody I think would suggest that by increasing a growing child's rations, its fingers could be induced to grow whilst its arms remained the same length.

I have quite often emphasized the fact that nitrogen is more effectively used in the later part of a cycle than earlier on and I have attributed this to the greater size of the bush with its enhanced foliage and root system. If this contention is correct, then such an effect should not be confined to response to nitrogen. It should be common to phosphoric acid and potash. The response to the latter nutrient has only recently begun to show, but an examination of twelve years responses to nitrogen and phosphoric acid shows that the proportionality between them over the whole range of years and cycles is unmistakable. The validity of the original hypothesis is accordingly strengthened. Manurial response is greater the better the bush is provided with roots and foliage wherewith to garner and synthesize the nutrients applied in the manure.

My purpose so far has been to try to change the emphasis which I feel has been far too common in the past, and I propose now to consider the question of defoliation from a different angle in the light of some recent experimental work on St. Coombs. But first let me say that the effective life of a leaf is not indefinite, even with an evergreen. Leaves are continually falling off, severed from their stalks by perfectly natural processes when their work is done. Naturally the older leaves and those which by reason of position and consequent competition for light are least effective, fall first. This really involves to some extent a distinction without a difference. It should be obvious that if the leaf is given a chance to remain longer on the bush because a longer cycle is being run: if also the lower leaves are on the same account being heavily shaded, then the lower branches of bushes running long cycle cannot be as thickly clad as those running shorter periods other things, e.g., the balance between foliage and flash, being equal.

I have already said that you cannot alter that balance by manuring. How can it then be altered? The answer is by resting. In the last week of October two

areas of tea were pruned on St. Coombs. They were cut-across at 18 inches from the ground preparatory to having the thinner twigs cleaned cut. One of these areas had been plucked for two years and then cut-across at 15 inches and allowed to rest for 10 months. The differences in appearance between the two has been remarkable. The unrested tea was devoid of foliage below the running level; an eighteen inch cut-across was actually a clean prune. Recovery from pruning has been quite normal but it is not yet ready for tipping after 82 days. The rested area retained a good canopy of foliage after pruning. From the distance the only difference noticeable between that area and the surrounding tea was colour, the pruned tea appearing darker. A certain amount of that residual leaf suffered from scorch later but a good deal remained intact. The effect of the rest has been to maintain and encourage the foliage growth on the bush and to speed up recovery, for the area was ready for tipping in 74 days and is now in production again.

On the consideration of the physiological aspects of this result I am not going to embark. There is no time to do it, and little knowledge relevant to the crop on which to base such consideration. But this fact remains, even though the explanation in detail has to be waived, that Blister Blight or no Blister Blight, the antidote to thin bushes, and the alleged defoliation, is to treat the bushes reasonably and, when in doubt rest them. It is no use resting for a few weeks or a few months only. Circumstances alter cases but at St. Coombs nothing less than 9-12 months seems to safeguard the foliage cover. A three year field on St. Coombs was rested without any preliminary cut-across late in July and has just been pruned. There is no canopy of foliage left: the lower leaves had disappeared before resting was started. Nor is resting beyond a twelve month period at a stretch any great advantage. Two areas were put under experiment, one to rest for a year, and one for two years. The purpose was to bring two prospective halves of a single experiment into the same pruning cycle. The area rested for two years had the centre cut out at 18 inches half way through the two year period. The difference in results does not appear to have justified the longer period.

Finally, I propose for serious consideration a system of periodic rejuvenation. It might have been done during the period of tea restriction, but although some areas of tea were rested, they were abandoned rather than rested and the benefit was neither properly distributed nor reaped to the best advantage. I suggest that for tea on a three-year cycle three periods be run after which the tea shall be pruned and rested for a year. It seems to me that the loss of yield from 10 per cent. of the acreage will be more than offset by the enhanced productivity of the balance of the acreage.

After twenty years spent in exploring the possibilities of manuring tea, my parting motto to you is 'look after the bush and the manures will look after themselves.'

MR. R. L. MC CONNELL said that twenty or twenty five years ago it was common usage to lop and fork in the prunings at the time of pruning. That was done less frequently now and he asked if there were any reasons for or against the practice.

DR. EDEN said he thought the main objection some people had to the forking in of prunings direct was the fear that this might cause root disease. Later it became recognised that, except possibly for Rosel-

linia, the risk was a small one and it became fashionable to recommend forking in the prunings. The only advantage he could see for the forking in of prunings direct was that by this method more material was incorporated in the soil. There was a general fear that if the leaf from prunings were allowed to drop off, or were beaten off after drying, some essential nutriment might be lost in the process. That was not the case. If the leaf was left to fall off and rot on the ground loss of nutrients would occur, but if the leaf were forked in immediately it was detached from the pruning sticks, there was no loss at all.

He regarded the question as to whether one should fork in prunings direct or merely fork in the dried leaf to be one merely of cost and convenience.

MR. MC CONNELL asked if there were not another aspect of the question — soil aeration.

DR. EDEN thought it was difficult to say whether soil aeration produced by the incorporation of whole prunings was superior to that obtained from leaf fall only. He said the practice of cultivation with the fork, or in temperate agriculture with the plough or harrow, appeared to him to be one of trying to crack a Barcelona nut with a sledge hammer. Soil aeration sufficient for the plant could be secured if the rainfall were made to percolate through the soil instead of running off this. The air referred to in soil aeration was not so much air in the pores of the soil as air dissolved in the soil water. Provided the normal rainfall was being passed though the soil by a process of easy percolation, then it should not be necessary to fork or disturb the soil with a cultivation instrument to anything like the extent that was commonly practised. The use of cultivation — and of course it was useful—depended on factors other than soil aeration and he did not himself think he would expect improvement in soil aeration from whole prunings in comparison with pruned leaf only.

MR. F. A. BOURKE asked how Dr. Eden regarded the practice of burying prunings in pits as distinct from forking them in.

In reply Dr. Eden said he had been trying the burying not only of prunings but of weeds and other similar materials in pits and he was all in favour of this practice if it were done properly. He did not consider that the root damage caused by the digging of pits was excessive. Some damage there must be but if, after the pits were dug, these were filled with green manures or organic debris of that sort, then there was something into which the roots of adjoining bushes could easily penetrate. The increased penetration of the roots and the good nutrition thus secured would, in his opinion, more than compensate for any root damage.

He would link the question with the previous one. He had already said that the main purpose of cultivation was for something other than aeration though aeration played a part. He would amplify this by saying that an important aspect of cultivation in tea was to give living space for the roots. Tea had had a very weakly penetrating root system. Anything in the nature of an unkind soil was fatal to tea. By a system of using green manures in pits penetration was assisted and the roots often got below the gravel pan, especially in patna soils. For these reasons he was in favour of the practice.

The Chairman asked whether tea in general in Ceylon could not receive considerable re-invigoration by a more inten-

sive process of growing and burying green manures than was at present being done on estates.

DR. EDEN said his answer to that would be partly yes, and partly no. Very intensive green manuring, if carried to excess, could actually reduce crop but he was unable to say when the critical line between sufficient and excess green manuring should be drawn. When there was excess a surprising increase in crop was obtained when the time came to cut out the green manure. But obviously the aim should be to produce green manures up to that limit. That limit would have to be determined by rule-of-thumb methods by every superintendent for himself.

With that reservation he would say yes to Mr. Scott's question. The success of green manuring depended on the management of such manures. He was constantly asked whether such and such a green manure contained more nitrogen than another kind. Such questions were almost irrelevant because success depended more on the quantity of green manures you could get into the ground than upon its constitution, provided the material had more than two per cent. of nitrogen in it. He thought that with proper management of green manures, the increase in vigour, health and crop which could be achieved in Ceylon was very considerable indeed.

MR. C. D. GIBBON enquired if there was any advantage in resting before pruning.

DR. EDEN said it depended on the period of the cycle at which resting was done. He had had good results by allowing a field which was in plucking to run away with itself and rest when it had only been plucked for a year. But if one took a field three years old from the last pruning and left it to rest before pruning one was not contributing anything to the lower canopy of foliage. The rest itself, quite apart from the question of foliage, might be the means of putting into the roots a greater reserve of starch. But that was not a thing which could be established as a general practice because, when tea was rested, there might be such an accession of growth to the bush that this would use up all the carbohydrates which it was manufacturing and also part of the previous reserves in the roots for new growth. As a method of bush rejuvenation, he would say that the more profitable way would be to prune first and in that way secure that lower canopy of foliage necessary to start off a good, new plucking table in the succeeding cycle.

MR. BOURKE asked if prunning had the effect of a shock on poor debilitated bushes.

DR EDEN said that that was not the case, it was one of those anthropomorphic analogies which did not hold. There was no such shock as took place in men and animals. Provided food reserves were present in the roots, one might expect the bush to put out new shoots and produce a healthy and vigorous growth. If that were not the case people would have abandoned collar pruning, years and years ago. Collar pruning was of course an operation which was not resorted to except with the gravest necessity but it was a better proposition up-country than at lower elevations. This was because on an up-country situation one could reasonably assume that sufficient starch reserves of food would be available to provide for the renewal of the tissues of the bushes which was not the case at low elevations. In the sense, however, in which the question was

put he did not think there was anything to be said to support the idea of a "shock" effect in pruning.

DR. GADD said that the amount of food reserves in debilitated bushes varied considerably. Some bushes had a fair amount, never very large, and others had none or practically none. When reserves were very depleted it was inadvisable to clean prune the bushes as that would result in their deaths.

The Conference then adjourned until 10 a.m. on the following day.

In opening the proceedings on the second day the CHAIRMAN said :—

It may interest you to know that the number present for our session in this hall yesterday afternoon was 320. I am very pleased to see so very many here this morning, because the papers that you will hear are of considerable interest to you, as no doubt will be the discussions that follow. After Mr. Horne's paper it is proposed to adjourn for ten or fifteen minutes for a cup of tea for which we are indebted to the Tea Propaganda Van, and thereafter we will reassemble for discussion on any points you may have to raise. I have great pleasure in calling on Mr. Lamb to read his paper.