THE EFFECTS OF CULTIVATION AND WEEDS ON TEA

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Four years ago at the Fourth Conference of this Institute Dr. Gadd and I dealt with the effect of drought on the growth of tea. Our inspections of droughty areas before the conference and the discussion that ensued showed that there was a striking concensus of opinion that 'high cultivation' had been no help in droughty areas but rather the reverse. Forking, weeds, green manures and mulching operations were all discussed at the time, but by way of explanation there was a peck of speculation for every pound of uncontrovertible fact. As a result of that very stimulating discussion and of my visit later in the year to Assam where cultivation practices are quite different and equally provocative, the Institute set out an experiment to explore the effects of cultivation and weeds. That experiment completes its first 3-year pruning cycle in April, and, as subsequent discussion may turn very largely, I suspect, on what we did or did not do there, and perhaps on what we ought to have done, I shall briefly describe the scope of that experiment.

Every plot was either clean weeded or selectively weeded (*i.e.*, all grasses and hard stalked species removed). Each plot had either a single forking of both rows on the occasion of annual manuring, or had three forkings of both rows annually. The two extra cultivations on those plots so treated were given at 3-month intervals so that the three times of cultivation were June, September and December; the June forking being common to all plots. I shall refer to these two treatments as normal and intensive cultivation. In addition each plot had either a single or a double dose of a standard manurial mixture. Combining these variations of treatment in as many ways as possible we are provided with eight different treatments. Those plots where weeds were allowed to grow and where normal cultivation was carried out had their weeds slashed at ground level on those occasions when their intensively cultivated counterparts were undergoing that treatment.

SOIL CONDITIONS

Any discussion of the problem that is engaging our attention this morning must take account of the soil, the plant's root system and its cropping growth, and I propose to deal with our experimental

investigation of these points as briefly as I. can. Those who are interested in learning the details of the technique used will have an opportunity tomorrow during the demonstration that is scheduled in the conference programme. I am giving only the bare bones of the matter here. First of all we have procured an efficient implement for measuring the degree of compactness of the soil, obviously a matter of prime importance in estimating the gross physical results of cultivation and the duration of any effects produced. This instrument, the Culpin soil probe, forces a thin steel probe into the soil, and at the same time draws on a revolving chart a trace which shows the depth of penetration and the force (measured by the extension of a coiled spring) that is necessary to push the probe home. Figure 1 gives three examples of the traces obtained in this way: it should be unnecessary to say that the curves depicted are averages of a large number of replications.

The dotted curve represents the state of the soil 160 days after cultivation during which interval 55 inches of rain fell on a total of 106 days. The average intensity worked out at a quarter-of-an-inch per hour of actual rainfall. The general form of the curve shows that soil resistance is negligible until about the tenth inch, after which it rises steeply to become relatively stable at 14 inches. The points of interest are two (1) that on these plots, which were very carefully forked indeed, the full effect of cultivation is felt only to a depth of about 9 inches, (2) that five months after cultivation these plots, which were carefully isolated by a fence, showed little or no capping or caking of the surface For simplicity's sake I have not complicated the diagram with the corresponding trace made immediately after cultivation, but I shall ask you to take my word for it that the two traces are identical, within the limits of accuracy of the method, in this region. The direct comparison will be on view tomorrow.

By way of contrast, the continuous thin line shows a trace from a normal field three months after cultivation. The depth of forking is not so great but the main feature of the curve is the peak in the first inch or inch-and-a-half. This is indicative of a pronounced 'cap' on the soil formed as a result of the constant treading of the soil under any and every type of weather condition. The conclusion is that heavy beating rain does not by itself quickly destroy our surface tilth, a conclusion which it appears from other considerations may be a characteristic of certain tropical soils, and is at variance with similar findings on temperate soils. But the constant treading under adverse soil moisture conditions that would scandalize any English farmer, does denature the surface soil forming a relatively impervious barrier to the percolation of rainfall. It is evident that

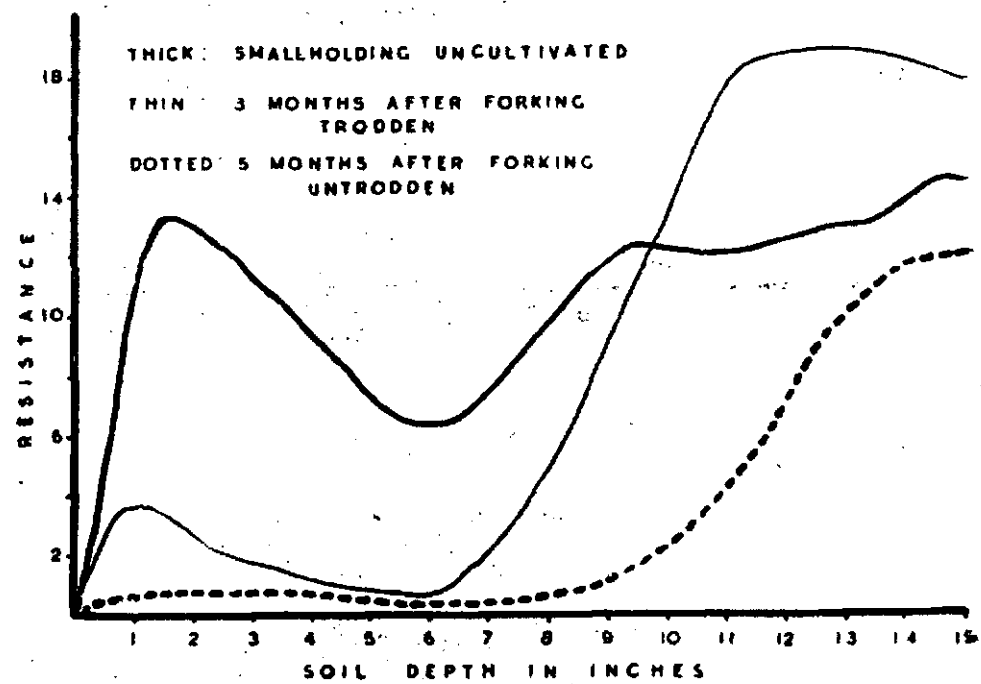
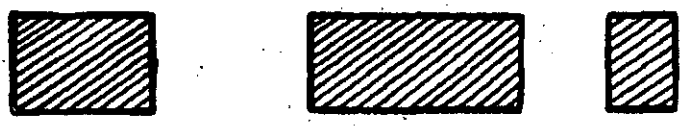


Fig. 1 SOIL DENSITY DISTRIBUTION



TOTAL ROOTS: RELATIVE WEIGHTS

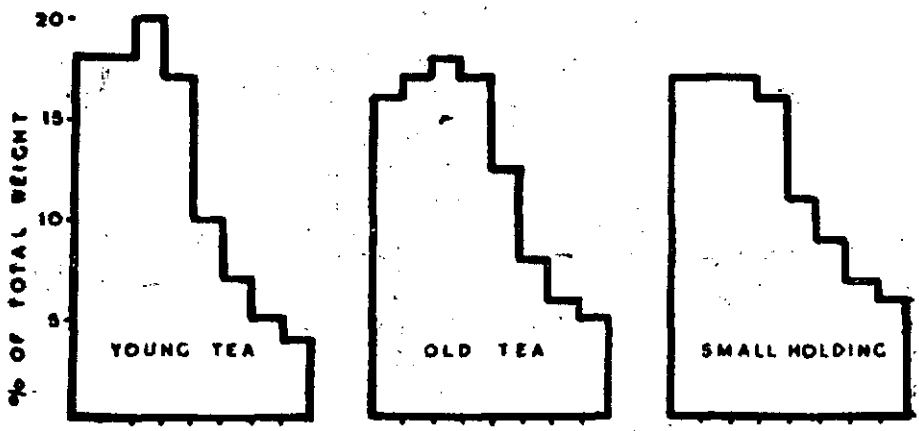


Fig. 2 ROOT DENSITY DISTRIBUTION

though at four or six inches depth the cultivation effects have deteriorated but little, the percolation of rainfall is determined by the initial two inches, and hence run-off and soil erosion are encouraged. The remaining curve gives the picture from an uncultivated small-holding showing to an exaggerated degree the features to which attention has been called. In the case of the soils depicted by the continuous lines we have information about root distribution and this will be referred to in due course.

ROOT DISTRIBUTION

The question of how roots are affected by cultivation has been answered by taking a large number of sample blocks of soil from which the feeding rootlets were washed out, dried and weighed. You will see the process in action at St. Coombs tomorrow, and I shall be prepared then to give my reasons for adopting this method of root investigation since time does not permit of such a digression here. The blocks of soil were of course carefully standardised in size and each one had a volume of $8 \times 8 \times 3$ cubic inches, the latter figure representing the depth in the soil. Such a block was a sub-sample from one location and at each point eight such sub-samples were taken, depth by depth, till the total penetration was 24 inches. The first intention of this work was to determine to what extent cultivation influenced root distribution. The lower diagrams in figure 2 express the weight of roots found in each layer as a percentage of the total roots found down to two feet. In all three cases the distribution is similar irrespective of the degree of cultivation attained: the 'young' tea and the small-holding samples were taken from the sites from which the soil resistance data were compiled. The large differences in soil density are not reflected in large differences in distribution of root density. Assuming an average depth of twelve inches for the range of direct cultivation effects, we find that the percentage of roots in the first twelve inches is 74 for the young tea, 68 for old and 67 for small-holdings. We have washed out over 1,000 samples in order to get these data, but there is still a chance that this virtual equivalence in distribution may be a coincidence. At any rate we can say that so far cultivation, as normally practised, is not an over-riding factor in determining root distribution. That cultural treatments of all kinds affect the gross quantity of roots is evident from the upper diagrams representing the total quantity of roots found per sample

In conditions of drought, small differences in distribution of roots at lower levels may assume an importance not evident at other and more normal times. If we imagine the first fifteen inches of all these soils to have been depleted of such moisture as plants can make use of, *i.e.*, if we assume that the root system above the 15-inch

level is out of action, then the differences in the proportion of the whole root system that remain in action to maintain the growth of the bush assume some interest in the three cases. The smallholding would then appear to have an advantage over, for example, young tea. Whereas the former has 22 per cent of its root system in action, the latter has only 16. This aspect must be followed up before the general proposition that uncultivated tea will have an advantage over cultivated in effective root distribution in dry weather, can be seriously maintained. We shall concentrate on the attempt to confirm or confute this preliminary evidence.

CULTIVATION AND WEEDING EXPERIMENT

CROP RESULTS

PER CENT INCREASE OR DECREASE FOR VARIOUS TREATMENTS.

		Mean
(a). *Decrease due to intensive cultivation.*		5.3
(b). *Decrease due to weeds.*		
With intensive cultivation	8.7	7.4
With normal cultivation	6.1	
(c). *Increase due to manure.*		
With intensive cultivation	11.4	13.9
With normal cultivation	16.4	
(d). *Increase due to manure.*		
With clean weeding	12.8	13.9
With selective weeding	15.0	

We come now to the cropping capacity of the bush itself under different systems of cultivation. If no radical changes are effected in root distribution can over-cultivation diminish root efficiency and quantity to an extent capable of reducing yield? The figures in the accompanying table show a diminution in crop as a result of intensive cultivation of just over five per cent, and the trustworthiness of this decrease is assured. It is probable but not certain that this decline is connected with a restriction in the actual amount of roots produced under these conditions. There is a definite drop in yield owing to the competition of weeds and that drop is experienced whether the weeds are left on the ground without disturbance for a year, or whether they are checked by forking at the aforementioned

intervals. I am not prepared to vouch for the apparent slightly increased loss when intensive forking is combined with the selective weeding. Manuring has produced a distinct effect, and the point to which I wish particularly to draw attention is that the benefit of the extra manure has been felt by the selectively weeded plots to an extent at least as great as by the clean weeded plots. I put it this way advisedly because the two per cent difference tabulated cannot be spoken of with confidence.

FUTURE CULTIVATION METHODS

Such in compact form are the results obtained from this investigation. They are, as it were, individual pieces in a rather complicated jig-saw puzzle and in the rest of the time allotted to me I am going to try and describe in imagination what the whole picture may well look like when all, or at any rate more, of the pieces are in place. Other people may build a rather different construction in their mind's eye. If so, I hope they will contribute their views and experience to the discussion.

The picture I should draw of cultivation in tea, shall we say in another ten, twenty or it may be fifty years, is as follows: Cultivation will not be abandoned; there will be no attempt to grow tea on a 'forestry' principle, but there will be a greater realisation that the main function of cultivation is to ensure that water percolates through the soil, and that the porous or 'crumb' structure that allows of this depends more on the *kind* of cultivation than on its frequency. Where nowadays energy is spent on forking *after* the establishment of the tea, in the future, some of that energy, and the money spent on securing it, will be diverted to the initial preparations. In temperate farming great care is spent on preparing a 'seed bed.' Here I think we should prepare with equal care a 'root bed.' If we cannot forcibly alter root distribution by cultivation, let us at least alter root volume. Planting, or replanting will be on contours, strict or modified, and planting will be done in trenches not in holes. Cultivation will be reduced to the number of occasions on which something necessary to secure adequate growth or adequate soil structure can be economically supplied. This means no plain forking. But from the point of view of soil erosion the soil cap must be destroyed. I do not envisage a return to shallow forking, because that is not an efficient way of incorporating artificial or green manures, but I foresee an attempt by means of mulch and ground cover to protect the structure of those vital few inches. Unless some miracle in the form of a ground cover with no attendant disadvantages is discovered, that ground cover will be weeds.

And I hear you say — What about the inevitable loss of crop? In less than twenty years' time I hope it will be realised that the best way of saving soil capital and at the same time maintaining crop — on a long view — will be to compensate for that loss by means of adjusted manurial supplies, until that adjustment becomes unnecessary. If clean weeding is abandoned, it is possible, perhaps even probable, that a drop such as we have demonstrated here, may occur. But what the advocates of clean weeding have yet to consider is whether the last state of that clean land is not worse than the first. The indications from our experiment are that the loss of crop from weeds is not getting bigger. Because it occurs in a year or so it is forced upon our attention. It is the men that succeed us that are going to notice the loss due to soil erosion.

CONFLICTING VIEWS OF SELECTIVE WEEDING

And that brings me to the question, on which views are so conflicting, of why some reports on selective weeding are favourable and some otherwise. Experiment has shown that under carefully controlled conditions both weeds and severe soil disturbance are detrimental. On an estate that has been carefully weeded by hand and is in a high state of production I should expect selective weeding to cause a decline at first. There is only one detrimental factor to consider, that is weeds. But on an estate where weeds have grown profusely and have been energetically attacked, I believe a different behaviour is probable. We know for example that *Drymaria cordata* can easily get the upper hand. It flowers profusely and in a short time; a monthly weeding round is not sufficient to prevent its spread. It has been scraped out and forked out, and the only result has been to push the ecological balance over onto the side of rapid advancement, for virtually all competitors are removed. At this stage, having concentrated on two adverse factors, weeds and root disturbance, the selective weeding programme is put into operation. A mixed flora results and root disturbance over and above the average ceases. One contrary factor is removed and so yields increase. I should like your comments on this. My experience is that under selective weeding good fields suffer, bad fields improve. The illustration I have given is of the two extreme cases and all sorts of intermediate gradations exist.

You may be surprised to find that cultivation is not an unmixed blessing, and equally surprised to find that in other systems of agriculture similar results are being obtained. The Rothamsted and Cambridge work on cultivation shows that there is a limit beyond which cultivation gives either no positive or even a negative effect. I have on another occasion dealt with the fundamental reasons for

cultivation. Let no one say that my contribution to this conference discounts the need for adequate cultivation. I must stress this, because in this country everything is exaggerated and one's pronouncements are made to appear either pure white or dead black. On the evidence as it stands, annual forking over the whole acreage seems to be the norm from which to arrange the cultivation programme so as to make the best use of artificial manure, green manure and compost, or to preserve a mulch of leaf and ground cover for the better protection of the soil.

DISCUSSION

MR. W. J. RETTIE said that Sir John Russell had touched on an interesting question — that of time of distribution of manures and the availability of plant nutrients. The Tea Research Institute recently had come forward with a very definite pronouncement on the subject. There were, he said, others who were of a different opinion and if, in the face of differing opinion people were loth to abandon certain practices from which they had had good results, he was sure that the officers of the Institute would understand. He referred particularly to pruning mixtures. They had had experts in the past who had laid down the law about certain agricultural practices which when followed were found to be impracticable; for example only a year ago they had had one such case when people had been actuated by what he might call the compost urge. Had they followed that urge they might have found themselves very deeply involved. On the question of pruning mixtures he did not wish to give his own experience beyond saying that some of those present, himself included, had had under certain conditions excellent results other than crop results. The gentleman who had originated the idea was present and the speaker thought it would be of interest to all if that gentleman would give them his views.

MR. P. A. KEILLER said that he did not agree with the Institute's opinion on the subject of manuring at pruning time. Perhaps the difference of opinion lay in the fact that Dr. Eden's arguments were based on crop figures and his were not, which put the speaker at a disadvantage in such arguments because it was much easier to argue from figures than to speak definitely without them.

He regarded the action of manure as being profoundly modified according to whether the bush was being plucked or unplucked at the time of manuring. The act of plucking induced an abnormal development of leaf that gave them the crop for which cultivation was undertaken, but this leaf growth did not stand in the proportion

to wood that was ordinarily the case when the bush developed normally. The manure applied when tea was plucked was used in giving more crop, *i.e.*, in developing new shoots which the act of plucking brought into being. The proportionate development of wood to leaf did not take place unless plucking was stopped, because food material was diverted to leaf production. On the other hand manure that was applied when the bush was not being plucked did not merely stimulate wood growth but supplied food for the bush to grow normally. He thought that they would get the wood they wanted when development of wood and leaf took place in their proper proportion.

The only time that tea was not plucked was between pruning and tipping, and the manure applied at pruning would be expected to encourage the natural development of the bush with regard to both leaf and wood. That growth was difficult to measure and there he was at a disadvantage because he had to speak in terms of general health of the bush and not in terms of pounds per acre. Referring to personal experience he could assure them that he had improved a great deal of tea by manuring at pruning time, not as regards increase of crop in the first twelve months, but as regards a very definite improvement in wood and the inducement of healing, *i.e.*, the growth of callus tissue over pruning cuts, both old and new.

Mr. Keiller reminded the conference that conditions had changed in the past fifteen or twenty years. When he was endeavouring to demonstrate the benefit of manuring at pruning time, much of the tea was in pretty poor condition and that fact would be remembered by those who knew Ceylon tea during the war period and before it. At the end of the war the tea was suffering from four successive years without manure and showed much wood decay in the pruned branches which had already been in evidence as far back as, say, 1910 or 1912. That tea had greatly improved and he had seen a progressive improvement since 1920-22 when pruning applications were first taken up. The symptoms were perhaps not so striking now, and those who had not had long experience of our tea might conclude that there never had been any need for a pruning mixture, but personally he was under no such delusion. Some people said that good tea did not require manuring at pruning time but that poor tea did. If that were so, it seemed not unreasonable to expect that good tea would become poor tea again if the pruning time treatment were withheld. His concern was not only with regard to crop but also with regard to wood-growth and general vigour, and he held very strongly that manuring only during plucking was manuring for crop. He was all for manuring for crop but not only for immediate crop, and he felt certain that they could safeguard their tea in other

ways by ensuring that the manure was taken up when the bush was not being plucked, *i.e.*, between the dates of pruning and tipping.

DR. T. EDEN in reply began by saying that it would be well to clarify the difference of opinion that existed between Mr. Keiller and himself. He had never suggested that a first year mixture should be discontinued. The crux of the argument was whether it was better to use that mixture at pruning time, or at a suitable date later. If one used the mixture at pruning time, some good would be done and Mr. Keiller was entitled to argue that he had seen the benefit from pruning mixtures. The speaker's position was that he considered the efficacy of the manure could be increased by delaying its application. He would start by asking why wood was desirable. He thought Mr. Keiller would agree with him that wood was wanted so that eventually crop should result from it. If it were possible to rear a strain of tea giving twice as much wood for the same amount of crop, he thought Mr. Keiller would confirm his own view that such a strain would be of no particular advantage (Mr. Keiller concurred). Mr. Keiller's argument was based on the correlation between wood produced and crop produced. The Tea Research Institute's experiments established two things: First that there was a very close relationship between the two types of growth under consideration: what Mr. Keiller had inferred as a matter of observation they had confirmed as a matter of direct experiment. But the argument cut both ways, if wood was followed by crop, then wood must precede crop unless in the meantime the system of management of the bush was altered. In the second place experiment had shown that at tipping time there was no difference between the weights of whole tippings from plots that had received a pruning mixture and those which had not at that time received any manure at all. He maintained quite definitely that tippings were an adequate criterion of wood production during the period under review. Whatever effect Mr. Keiller was ascribing to the pruning mixture, he (Dr. Eden) could say with equal certainty that it did not show up at tipping time. Thereafter they were both on common ground because manure used subsequently would increase both wood and crop.

At the time of speaking they were 21 months from the last pruning, and those plots that received their manure six months after pruning were 75 lb. per acre ahead of the pruning mixture plots. He was entitled to ask Mr. Keiller how long they were to wait for the result of this delayed action of increased production of wood of which Mr. Keiller made a point. There was a limit to the period during which this delayed action could be effective because at the end of the cycle they pruned away the wood and experimental experience showed that in so doing they brought back the cropping level

to about that of the previous first year period. Though other factors in management might alter the proportion of wood to crop he maintained that such alteration could not be made solely as a question of manurial practice. He was not prepared to accept Mr. Keiller's premise that the ratio of wood to leaf was greater in the initial period than subsequently, but that was a matter of opinion. What was not a matter of opinion was the 75 lb. extra crop secured to date. On these and on general botanical and physiological grounds he felt that it was wrong to dissociate, as Mr. Keiller had done, the questions of crop and wood production.

MR. H. J. TEMPLE asked if they might have Dr. Gadd's opinion on the relative effect of a pruning mixture on wood and leaf growth.

DR. C. H. GADD said that the problem which had been discussed by Mr. Keiller and Dr. Eden was one which allowed of a botanical explanation. There was a very definite relationship between the radial growth of a stem, *i.e.*, its increase in diameter, and the extension growth of the leafy shoots. Increase in diameter of the stem was what has been termed wood growth while the terminal growth with leaf development was what in tea formed crop. To explain this relationship between wood growth and crop he likened the tea bush to a town, the houses of which were represented by the leaves. In such houses are many taps if the termination of each small vein may be regarded as a tap. When an ordinary suburban house is being built the plumber gets busy, lays the pipes within the house and when all is ready makes a connection with the nearest water main. When a tea bush house is built a connection with an existing water main is never made. Instead a new pipeline is laid down *via* the stem and the roots right back to the water reservoir which is the soil around the root tips. There is not merely one pipeline per house but one pipeline per tap, and the development of the pipelines must progress with the building of the house as water is required for the building. The pipelines referred to are wood vessels and the laying down of more vessels results in increase in girth of the stem. There was thus such intimate connection between leaf formation and wood growth that it was impossible to have one without the other.

Referring to Mr. Temple's question, Dr. Gadd said that the growth of root stem and leaf was so intimately connected that it was practically impossible to stimulate one without stimulating the others at the same time. As a stimulant at pruning time he thought that a pruning mixture could have little value as the presence of a larger amount of food material in the soil would not cause the buds to break any earlier. More important were climatic conditions. To illustrate his point Dr. Gadd referred to deciduous trees in England.

During the winter they were leafless and normally the buds burst in spring. A spell of warm weather in late winter often caused the buds to burst prematurely and that new growth was often killed by a late frost. Those conditions applied equally well to trees in the tropics. The bursting of buds after pruning depended upon such climatic factors as temperature and rainfall as well as upon the state of development of the buds themselves, and there was no apparent reason why the provision of a pruning mixture would speed up the breaking of the bud and the accompanying development of wood in stems and roots by so much as a day.

MR. S. F. H. PERERA referred to the subject of wind erosion. In Ceylon this type of erosion never received any consideration. In certain parts of the world where dry farming is customary they heard about wind erosion more than erosion by water and were told that fertile land was turned into desert. He wished to know what steps the Institute had taken to combat wind erosion in Ceylon wherever it occurred, and also what steps had been taken in other countries to combat wind erosion.

DR T. EDEN replied that the types of soil found in Ceylon were not so liable to wind erosion as those of other countries of which he had no personal knowledge. In Ceylon there was a type of dry erosion due to the disintegration of the soil mass on drying but that was independent of wind. He knew of no situation in tea where wind erosion occurred. The question of conditions in other countries he referred to Sir John Russell.

SIR JOHN RUSSELL said that typical wind erosion occurred when the land lay in great areas of rolling plains subject to hot dry winds and no rainfall for many months of the year. Under those conditions the practice had been to go in for strip farming growing a cereal crop of either wheat or maize in strips alternating with uncultivated areas. In the next year the strips were reversed in the hope of this keeping the soil anchored and capable of retaining the moisture of that year and carrying it on till the next so as to get two years' rainfall on one crop. That condition was not likely to arise in Ceylon since it was associated with big continental areas. They in Ceylon might congratulate themselves on not having that particular difficulty.

MR. L. B. GREEN referred to Mr. Wilkins' remarks about the harmful effect of sunscorch on tea that had no shade. This was naturally greatest in times of drought. But in similar drought conditions, if there were thick shade, there would also be heavy loss of moisture, not through sunscorch, but by transpiration through the leaves of broad leaved shade species, such as dadaps. He had personally noted the bad effect of drought on tea in a well-shaded

area, and thought it was largely due to loss of soil moisture through transpiration of the leaves of the cover. He wondered which was worse, that or the sunscorch?

He would also like to know of a simple test for determining whether the carbon-nitrogen ratio of finished compost was correct, so as to avoid having to send samples to the Institute.

DR. T. EDEN said he thought the circumstances under which sunscorch and excessive transpiration reacted unfavourably on tea were quite diverse. In young clearings the soil got heated up if no shade was present and it was possible for small stones and gravel to become so intensely hot as to scorch the stem of a young plant causing it to ring and die back. That happened to many supply plants. But the transpiration problem was one of mature areas. Even if the plant's own mechanism did not sufficiently stop down moisture losses, they could at a moment's notice reduce the loss by lopping. On the other hand they could not produce shade to order, so he always preferred to risk an excess of shade to any degree of sunscorch. Regarding compost, if the strands of the material from which compost was made were not evident, or if on pulling a lump of compost apart the remaining strands offered no resistance, *i.e.*, if the structural tissues had been destroyed, then they might infer that the carbon-nitrogen ratio had been adequately adjusted.

MR. J. D. FARQUHARSON said he appreciated the emphasis laid on selection in weeding and would like to know broadly how to classify weeds for selection, so as to tell the sheep from the goats.

DR. T. EDEN said that in the first place it was advisable to get rid of all grasses. They were such avid users of nitrogen that they might cause temporary nitrogen starvation for the associated crop. Regarding the other weeds it was hard to get a labour force to remove only grasses and hard stalked non-spreading species that were of little use in holding up soil, but the best plan was first of all to allow everything that would develop (except grasses) to do so. He would not say to individuals, encourage such and such species, because circumstances altered cases. But having succeeded in establishing a cover it would be found that a few, perhaps three or four, weeds predominated, species capable of spreading and standing up to competition. The labour force could be taught the identity of these few and then allowed to take everything else out. In a short time these remaining species would colonise the whole area and there would be little difficulty in keeping a reasonably complete cover.

MR A. N. PAINE asked whether the distribution of roots and branches closely corresponded and whether in that case there was a likelihood of ill-balanced growth on one side of a bush if manuring

was carried out in one row only owing to roots in that row taking up an undue proportion of the manure.

DR. T. EDEN replied that the answer to the question involved a reference to a demonstration that Dr. Tubbs had carried out in his department. Different lateral roots from the same bush had been immersed in dyes of different colour and the progress and destination of these dyes had been watched. This disclosed the fact that in the main the stream of food materials went in large proportion to localised branches. This was not entirely the case and a mechanism did exist for maintaining interconnection. This was also true for the manufactured foodstuffs produced by the co-operation of roots and leaves. He did not therefore think that there was any permanent damage to be expected from alternate row manuring.

MR. C. H. WILKINSON asked leave to confirm Dr. Eden's description of the manner of colonisation in selective weeding. From ten years' records he had found that three or four useful species formed a perfect ground cover.

MR. T. GLEN DICKSON asked whether selective weeding would increase cost of weeding, and if so, to what extent.

DR. T. EDEN replied that he could not answer the question as put because different circumstances would call for different answers. He thought the question of costing a system of selective weeding was strictly a job for the Superintendent who would then have to make his decision. The Institute could give Superintendents the agricultural facts. It could not give costing figures applicable to all circumstances.

MR. I. L. CAMERON said that Dr. Eden had indicated that cultivation, and by that he understood forking, could be overdone. Dr. Eden had given one cultivation per annum as the norm and the questioner wished to know whether one alternate row or one forking in both rows was intended. Since shade trees and bush green manures would need more frequent lopping than once annually, would he advise leaving these as a mulch on the ground?

DR. T. EDEN said in the experiment both lines were forked at one time. The depreciation in crop of 5 per cent due to increasing forking from once to thrice was so small that he did not think one double row forking as compared with one single row forking would show any appreciable difference. He would fork in green stuff whenever the time coincided with a normal forking programme and at other times mulch the green manure.

MR. C. H. WILKINSON explained that in relation to Mr. T. Glen Dickson's question he could say that the cost of control of green cover and selective weeding in his trial was no more then than it was ten years ago.

MR. GORDON PYPER said that his figures over a period of ten years had never exceeded Rs. 1.75 per acre per month.

MR. R. A. PATERSON said that if the soil was denuded of all cover, in his experience, in dry windy weather, wind erosion did actually take place.

MR. C. DE LEMOS asked whether he was correct in assuming that at pruning time all feeding roots died back if all the leaves were taken off the bush. At the Nuwara Eliya elevation it took about six months for new leaves and feeding roots to form and he thought, on the assumption made regarding roots, most of the potential benefit from a pruning mixture would be lost.

DR. T. EDEN said that their root sampling observations had not proceeded far enough to give an answer. On the question of whether roots actually died or became dormant at pruning time he would leave Dr. Tubbs to say since he had made sundry observations on that point.

DR. F. R. TUBBS said that the experiments referred to had dealt with water uptake of pruned plants. Young plants removed from the ground with the greatest care and with roots immersed in water had shown a large decrease in water uptake as an immediate reaction to pruning, which suggested that on a mature bush after pruning the roots were at least reduced to a much lower state of activity.

MR. J. C. MITCHELL wanted to know whether the efficacy of pruning mixtures would be increased if they were not forked in at time of pruning. He wondered whether deep forking at pruning, by disturbing the root system, lessened the usefulness of the mixture and whether application two months prior to pruning would have a more beneficial effect.

DR. T. EDEN expressed his opinion that a pre-pruning mixture was no solution to the problem. His examination of records showed that pre-pruning mixtures had to make themselves felt before pruning either in crop or in some slight adjustment of food reserves. Once pruning had occurred no further benefit from the manuring seemed to occur. Experiments at Passara bore that out. He did not think that root disturbance at pruning would account for the lack of effect of manures used at pruning time which, as he had stated, gave no effective response at high elevations for 4 to 4½ months after application.