NEW ASPECTS OF MANURING.*

T. EDEN.

Last October, I took the opportunity of summing up the changes that have taken place in the last ten years in the use of artificial manures. Last time I visited this Association I dealt with the other important branch of manuring — green manuring. On both occasions I gave a picture which surveyed broadly most of the ground that these two subjects may be expected to cover. Today I am so to speak displaying a much smaller canvas and I propose merely to fill in some of the details. Agricultural research is in the nature of things slow work, and though some of the ideas I shall put before you today suggested themselves to me some years ago, I have refrained from giving them publicity until I had some factual proof of their validity to offer you.

I have chosen two quite unrelated aspects of manuring to speak about, both of which are much discussed in planting circles if my correspondence files are any indication of the state of affairs: they are time of manuring in the pruning cycle and the function of manuring in relation to the growth of the whole bush.

PRUNING MIXTURES

In the previous lecture, to which I have referred, I noted in some detail the data and general considerations which led me to question the universal efficacy of pruning mixtures. I shall not repeat that now except to remind you that the response to Nitrogen in the first year of a 3-year cycle was small in comparison with either the preceding two years in the preceding pruning cycle or the succeeding two years in the same cycle. I mentioned that in an actual experiment, at tipping time the new growth was not superior on the plots given an application at time of pruning to those which had received no application. The first year of the new cycle is just complete and the results show the effect of delayed application. Both the three and six-month applications are superior to the one at pruning time itself. The actual figures in pounds per acre speak for themselves. They are as follows:—

Months from pruning ...	0	3	6
Ist year yields lb. per acre ...	629	664	674

* Lecture given before the Madulkelle and Uva Districts Planters' Associations on May 6th and 28th respectively.

Now that some actual data on this point is available the opportunity can be taken to discuss the practical implications. Up to the present my pronouncement has not exceeded the statement that "considerable doubt is thrown on the efficacy of pruning mixtures."

We must first of all consider the conditions under which this experiment was carried out, namely a three-year cycle at an elevation of 4,600 feet with a period of recovery from clean-pruning of 4 months to first tipping and 5½ months to the completion of a third round of tipping.

The conclusion we are entitled to draw then is that a delay in application till tipping time is beneficial: if manuring is delayed till completion of tipping the extra advantage is in all probability not significant. It is necessary to visualize this experiment in terms of growth stages and not in months because otherwise it will be difficult to apply it to differing climatic and cultural conditions. Viewed in this way it is obvious that the advantages of delay in application in the pruning mixture is likely to be less noticeable at low elevations where recovery is more rapid, and particularly with other kinds of pruning such as the so-called rim-lung or cut-across. In both these cases the bush is not left to regenerate itself entirely from stored food reserves, and begins to function normally at an earlier date than with clean-pruning. Summing up on this point, the advantages of delayed pruning mixtures are most marked at high elevations on clean-pruned tea and will lead to some saving in the artificial manure bill. In those districts where drought is a serious problem, and where a considerable amount of dry weather pruning is carried out, delayed pruning mixtures give a period of grace, without any loss of efficiency, to enable dry weather cultivation to be avoided.

PRE-PRUNING MIXTURES

So much for the beginning of a pruning cycle. The end of the cycle is quite as interesting from a manurial point of view. The thesis I have elaborated that nutrients are less economically used at the beginning of a cycle than at other times raises the question of economic manuring towards the end of the cycle. If we employ greater amounts in the last few months than the bush can reasonably deal with, the unexpended portion of that application becomes uneconomic comparatively speaking as soon as pruning has been done. I think that follows logically from what has preceded.

I have not yet experimental facilities for putting this hypothesis to a test of the same stringency as the rest, but I have gathered a certain amount of suggestive data from estates themselves. I have

been interested in these pre-pruning mixtures for some years and have taken the opportunity of examining field data from estates wherever a settled policy of manuring has been in operation for some years. The procedure in dealing with this data is as follows:—

The foundation of the method is the now well-substantiated fact that when manures are economically used, the increment in crop is strictly proportional to the amount added.

Our experiments show that the addition of 1 lb. of nitrogen produces between 4 and 5 pounds of tea. Actually, the absolute value of this coefficient is unimportant for our purpose, but for sake of illustration the value 4 will be taken. We are now in a position to take any given yield over a period, and to assign that yield in part to soil sources of nutrient on the dual assumptions that a known amount of manure has been applied during that time and has been economically used. Thus, if in a ten-month period 662 pounds of tea was harvested, and during that ten months 33.25 pounds of nitrogen was known to have been added, the statement runs as follows:—

Total crop	...	662
Nitrogen equivalent (4 × 33.25)	...	133
Residual equivalent	...	529

Consider a similar statement made on the basis of only 20 lb. of that 33.25 lb. being used by the plant. Then a truer picture of the balance sheet would be:—

Total crop	...	662
Nitrogen equivalent	...	80
Residual equivalent	...	582

A comparison of these two statements brings out the point I want to stress, namely that *a diminution of the residual equivalent indicates that in the case of the lower value the utilization of added nitrogen has been less efficient*. This loss of efficiency may be due to diverse causes such as drought or other climatic reasons for diminished growth, or to overdosage of manure, but on consideration you will see that lack of response to manure by reason of adverse climate is really only another aspect of the same cause — inefficient use of manures.

In the following examples taken from actual records the pruning cycle is divided into periods between consecutive manurings and the various equivalents calculated. Since the time periods are not

absolutely constant, the residual equivalent is expressed in lb. per month. Climate must play a considerable part in determining the progress of growth over restricted periods, so we shall only consider large differences in values.

Example 1 shows what I consider to be a perfectly normal application of the principle to a short cycle with regular manuring at six monthly intervals. The first six months is anomalous because of the recovery period. The second shows a marked increase in residual equivalent and the third not merely a maintained but an enhanced, value.

EXAMPLE 1

Months from pruning	Nitrogen applied	Yield to-date
0	12	—
6	28.5	106
12	24	450
18	—	826

	1st Period	2nd Period	3rd Period
Yield	106	344	376
Nitrogen equivalent	48	114	96
Residual equivalent	58	230	280
Residual equivalent per month	10	38	47

Bearing in mind that a bush at this time has developed frame and root system it is reasonable to expect that its foraging value and productive plucking points are both increased, and are reflected in the calculated residual equivalent. When with rather closer spacing greatly increased quantities of nitrogen were given the results were those of example 2.

EXAMPLE 2

Period	2	3	4
Months	5-13	14-18	19-23
Nitrogen added	25	41	41
Residual equivalent	58	32	25

The steadily decreasing value of the residual equivalent is evidence that at such close intervals 41 pounds of nitrogen is uneconomically used and is an overdose.

Having demonstrated the principle by an exaggerated example, I shall pass to the consideration of end of cycle applications and show you some figures from a former manurial programme on St. Coombs.

EXAMPLE 3

(a).				
Period	1	2	3	4
Months	6	9	10	7
Nitrogen added	0	34	34	34
Residual equivalent	7	49	60	46
(b).				
Months	4	10	9	6
Nitrogen added	0	33	33	30
Residual equivalent	—	53	81	34
(c).				
Months	5	9	11	5
Nitrogen added	0	34	34	34
Residual equivalent	—	55	62	45
(d).				
Months	4	10	11	6
Nitrogen added	—	33	33	30
Residual equivalent	—	49	78	40

In these examples (a) and (b) are two successive cycles in one field and (c) and (d) similar cycles in another field. All show an increase to a maximum at the end of the 3rd period (20-25 months) and a severe falling-off for the final short period of 5-7 months.

There is no point in piling Pelion on Ossa by giving still more data on the identical point but I have a somewhat striking example in No. 4. Here are two fields which for a period had been on a 3-3½-year cycle with approximately annual manuring which were then put on an extended cycle, and to help them on were given an extra dose during the last twelve months.

The trend of results can in this case be best seen if the residual equivalents are plotted against the appropriate dates. In both cases the special dose following so soon after the 'normal' application has caused the equivalent to fall rapidly. Such a spacing in manuring is thoroughly uneconomic and stands condemned. The tendency in some quarters to apply ever-increasing quantities of manure up to the final dose does not appear to be necessarily a fruitful one, and

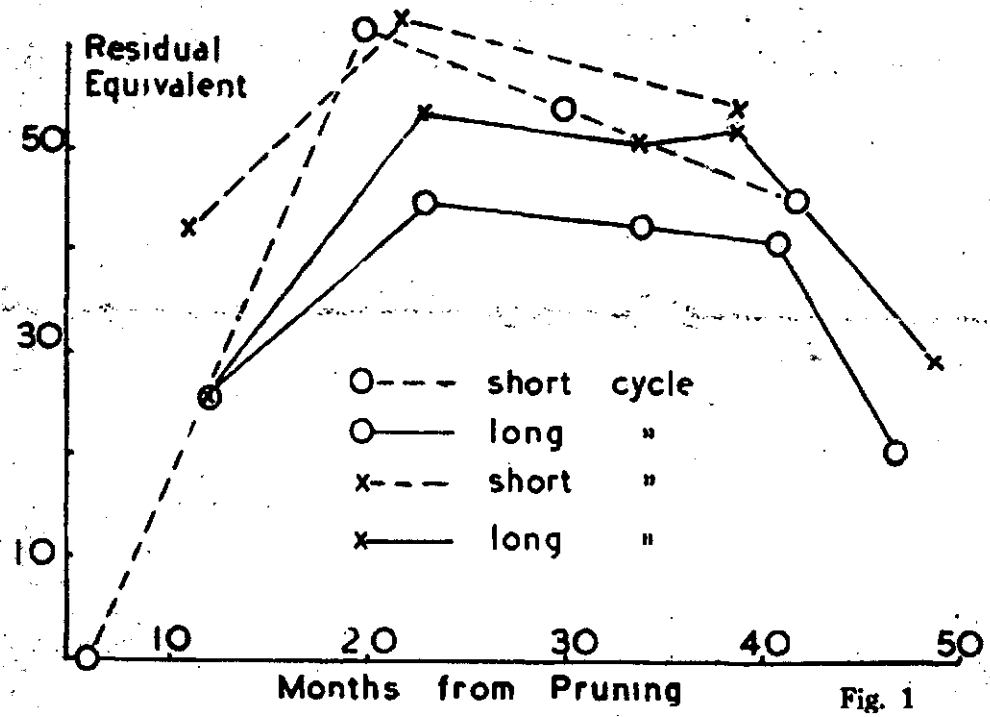


Fig. 1

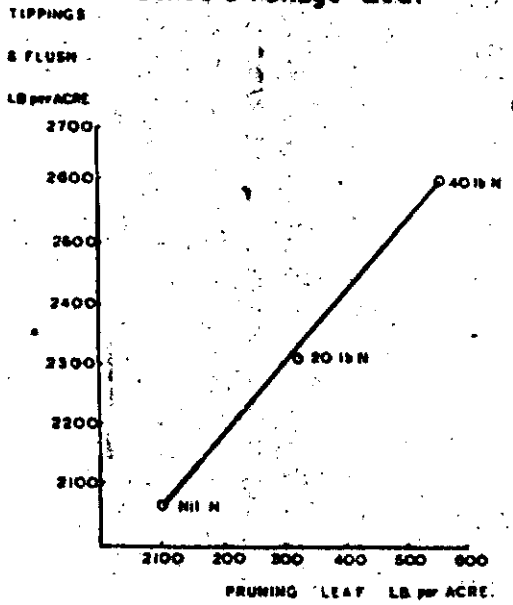
care is particularly needed to see that the final dose is of the size and at a period that allows of reasonable use before pruning. It would be well on principle to avoid periods of less than six months and even then to graduate the dose. We are working on this principle at St. Coombs and shall in due course have further data for examination. In respect of the graduated dosage, it is interesting to note that in going through my collection of figures I find that the maximum residual equivalent appears with real consistency at the end of the 20-25th month. The manuring previous to this date is therefore likely to be the most favourable for crop production.

MANURING FOR CROP AND WOOD

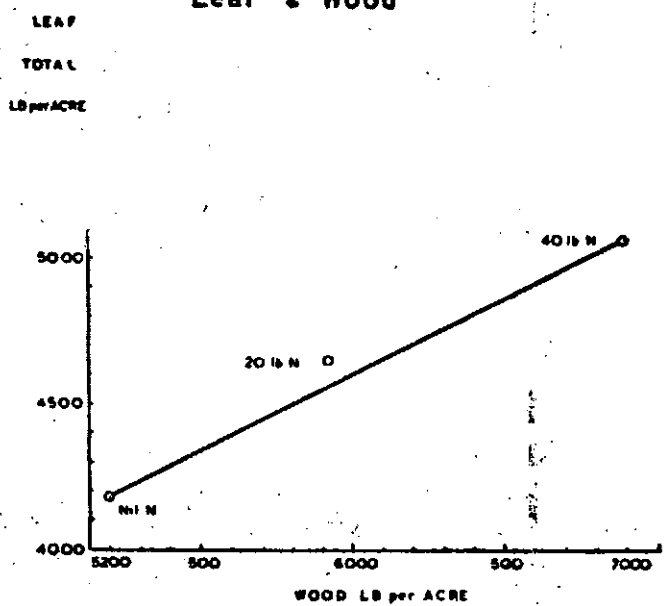
The second aspect of manuring I have chosen can be dealt with very briefly, but as it is important I am anxious to put it on record. Hardly a month goes by without my being asked to prescribe a manurial programme that will encourage wood growth without enhancing crop

Such requests ignore the fact that a plant is an organism and the growth of its various parts is highly correlated. It may be that the behaviour of orchard crops at home is responsible for the prevalence of the idea, but the case of tea is not comparable with that of the apple for example. In the latter case there are two distinct phases of growth, the vegetative and the reproductive. The latter depends upon the food reserves available rather than on direct

Relationship between Plucked & Foliage Leaf



Relationship between Leaf & Wood



nutrition and consequently reproductive growth is alternative to vegetative. But in tea all the growth is of the same type and the direction of growth into alternative channels does not come into play. The conclusion supported by direct evidence is that increased crop and increased wood go hand in hand. The various manurial treatments on our experiments show consistently this close connection. I have drawn out the data for increased quantities of nitrogen as a typical example. First of all there is the relationship between the leaf removed in plucking and that left on to support the bushes' activities. Three levels of nitrogen are considered and the proportionality of the yields as shown by the approximation to a straight line graph is as strict as any experimental demonstration can hope to produce. Similarly the relationship of total leaf and wood, or *a priori* crop and wood is also very close indeed. I hope when this lecture is given the wider publicity of publication it will suppress enquiries of the nature described. There are methods of altering the balance of wood and flush. The obvious one is to stop the plucking stimulus and allow growth to proceed after pruning till a good show of red wood has formed. Manuring will help this during the later stages but it will not be manuring that alters the balance.

NOTE.

In the course of discussion on the above lecture attention was drawn to the high values of the residual equivalent which might make it seem that without manuring a high yield could be obtained. Such a yield might appear to suggest that it would be more profitable to manufacture the yield equal to the residual equivalent rather than to spend money on enhancing crop.

The elucidation of this problem that followed brought out the following points:—

(1) That the hypothetical figures used for comparison refer to crop only.

(2) That the improvement in potential cropping response that follows manuring keeps the bush in good heart and subsequently makes it a better forager. Eventually, therefore, manuring has an effect on the size of the residual equivalent.

(3) That this is so is shown by figures quoted in a previous lecture Vol. X, No. 3, October 1938, where the ratio of crop to added nitrogen is gradually increasing. That this should occur is mainly due to the fact that whilst every application of manure starts where the last left off, the unmanured yields are steadily decreasing, *i.e.*, without manure the "residual equivalent" is not maintained.

(4) Over short intervals of time the residual equivalents offer a sound basis of comparison.