RECENT EXPERIMENTS IN MANURING OF TEA

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INTRODUCTION.

In presenting at this Conference a paper on the results of the Institute's manurial trials, I am conscious that to some this may appear to be a discussion on a luxury that at the present time the industry can barely afford. It is however just this anxiety about manuring that has persuaded me to take up the subject; the practice of artificial manuring is not a passing phase in the development of the tea industry, it is a permanent feature, and I hold that a time when economic conditions are forcing estates to reconsider manurial programmes, is precisely the time when research should be vigorously prosecuted. If this is done it may be possible to eliminate wasteful expenditure and to provide fundamental knowledge on which to act when more normal conditions return.

Agricultural field experiments are not begun and ended in a day. Before setting out trials it is necessary to consider not only which of the many problems are of chief interest and importance at the moment, but to cast a prophetic eye into the future and decide which will remain important despite changes in conditions that may occur before the work reaches fruition.

Three aspects of manuring were much debated when the agricultural chemical division of this Institute was started. These were the response of tea to potash, the relative efficiency of inorganic and organic forms of artificial nitrogenous manures, and the question of manurial balance. The potash question is fundamental and no change of conditions can diminish its importance. The nitrogen problem is even more important now than when the experimental scheme was decided on; conceptions of balance in manuring are notoriously elastic even though the gross error of using single nutrients only is a thing of the past.

The experiments I propose to describe to you were accordingly designed to answer the following questions:—

1. What is the effect of increasing doses of nitrogen on tea?
2. What is the effect of increasing doses of potash?
3. What effect have these two nutrients on growth when considered together (i.e., the effect of balance)?

4. How do inorganic and organic nitrogen rank with respect to each other?

The question of phosphatic manures was reserved for later investigation.

METHOD OF APPROACHING THE PROBLEM.

Before describing in detail the results so far obtained from these experimental inquiries, I want to digress for a short while to consider the best means of providing sound answers, and to lay a few ghosts of doubt about the relationship between agricultural experiments and practical methods.

The first point I wish to stress is that the programme outlined above asks one or two delicate questions. As an illustration let us take the differentiation between the effect of various kinds of nitrogen. In order to answer our question it is necessary to apply equal quantities of nitrogen in inorganic and organic forms. There is no likelihood of large differences between them in crop response. It follows that a high degree of accuracy will have to be attained if we are going to distinguish differences of a few per cent between them.

I have already on more than one occasion dealt with this question of accuracy. The proof of the pudding is in the eating. From knowledge previously acquired as to the relationship between experimental design and accuracy, evidence will be given that differences of 5·2 per cent in some cases and 6·6 per cent in others can be confidently regarded as real. I do not propose to burden you with complicated mathematical conceptions, but this level of accuracy corresponds with a standard error of less than 2 per cent. I submit that such conditions provide an adequate basis for deciding the questions in hand.

The experiment consists of a large number of small 1/12th acre plots for each treatment. You may ask how far the results are relevant on a practical scale. The whole experiment covered an area of 4½ acres. Within the limits of error aforementioned, the plots, small as they are, are truly representative of the whole 4½ acres.

There is no need to take fright at small plot results for which an error figure demonstrating their representativeness is available. I make a special plea for consistent thinking on this subject of small samples. Estates send down to the brokers small samples of tea for valuation and report. It is never suggested that half a break should be used for this valuation. That is because by mixing, a thoroughly representative small sample can be obtained. On the other hand I regularly received a single sample of soil occupying a few square inches of surface area from which I am requested to deduce results applicable to several acres. Such a sample is in no way representative. I hope I have made it clear that the value of a sample, be it of tea, soil or field area, is not a question of size but of representativeness. The use of small plots scattered over an area is analogous to the mixing operation in drawing a tea sample, with the added advantage that one can state exactly just how successful the operation has been. The bogey of small plots, like King Charles II, is an unconscionable time a-dying, but it is nevertheless only a bogey.

EXPERIMENTAL DETAILS.

Turning to the details of the experiment, there are three levels of nitrogen manuring and the same for potash, viz. 0, 20 and 40 pounds per acre. When combined in every possible way this gives nine different treatments relating to quality of manural application as shown by the diagram.

		0	20	40	Nitrogen
	0	**0,0**	**0,20**	**0,40**	
Potash	20	**20,0**	**20,20**	**20,40**	
	40	**40,0**	**40,20**	**40,40**	

Each of these treatments is replicated sixfold, so that questions of *balance* are decided on the basis of not one comparison but six. Questions of response to increments of nitrogen are based on no fewer that eighteen comparisons. The 36 plots that received nitrogen are divided into equal numbers receiving Blood meal, Cyanamide and Sulphate of Ammonia (i.e., 12 each), compounds which it has been customary to regard as representing an increasing degree of availability in the order stated. Potash was given in the form of muriate; the effect of phosphate cannot be judged from this experiment, as all plots received 30 pounds per acre of phosphoric acid in the form of ordinary superphosphate.

The pruning cycle is three years and the following are the dates of various operations of husbandry.

	1930	1931
Pruning	November 10-18	—
Manuring	,, 26-Dec. 3	November 23-25
Tipping	March 18-20	
	April 14-15	
	May 5	
Plucking	Regular nine-day rounds.	

Every effort has been made to secure accuracy in the routine conduct of the experiment. The correct amount of manure for each plot was weighed out into bags according to the rows to be manured in each plot. The interference of dew and rain was eliminated from plucking weights by sampling each plot in duplicate and, on the basis of the moisture determinations, reducing all yields to equivalent dry matter.

EXPERIMENTAL RESULTS.

Data are available for two complete years and the yields may be conveniently considered under the following heads:—

(1). Tipping.
(2). First year flush.
(3). Second year flush.

Tables 1 and 2 give the yields per acre for tippings and first year leaf respectively.

TABLE I

Yield of Tippings

	Nitrogen Quantities			Potash Quantities			Nitrogen Type		
	Nil	20 lb. per acre	40 lb. per acre	Nil	20 lb. per acre	40 lb. per acre	Blood meal	Cyanamide	Sulphate of ammonia
Yield per acre lb. dry weight.	296	316	326	312	309	317	319	316	328
Significant difference lb.		23·2			23·2			28·3	
Yield per cent of mean.	94·7	101·0	104·3	99·8	98·8	101·4	99·5	98·5	102·0
Significant difference per cent.		7·41			7·41			9·08	

Plate II.

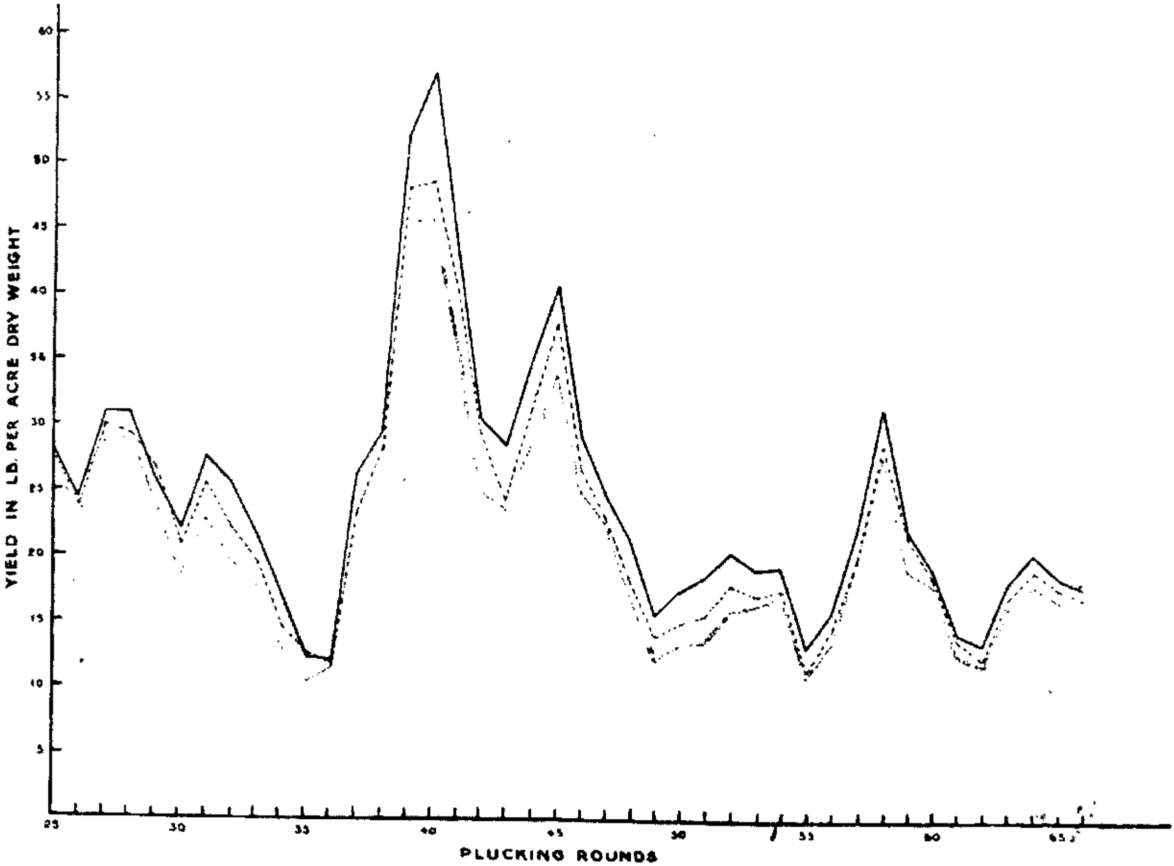

FIG. 2

YIELD PER ACRE FROM PLOTS RECEIVING VARIOUS QUANTITIES OF NITROGEN

SOLID LINE 40 LB NITROGEN PER ACRE
BROKEN LINE 20 LB NITROGEN PER ACRE
DOTTED LINE NIL

FIGURE 1 FIRST YEAR 1931
FIGURE 2 SECOND YEAR 1932

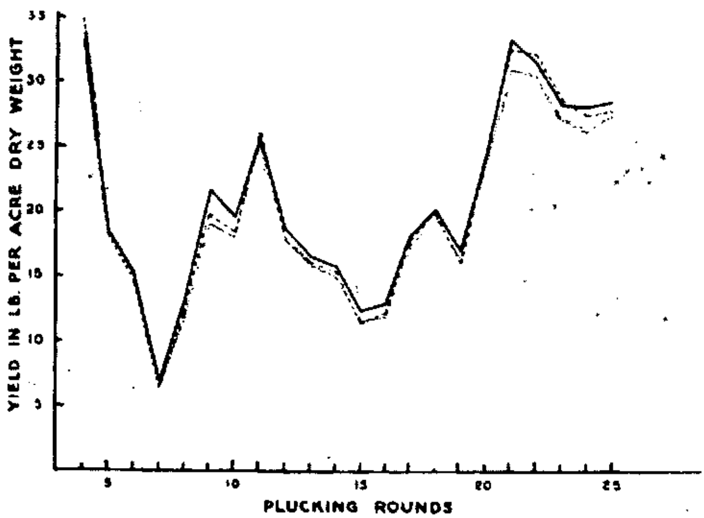

FIG. 1

Plate III.

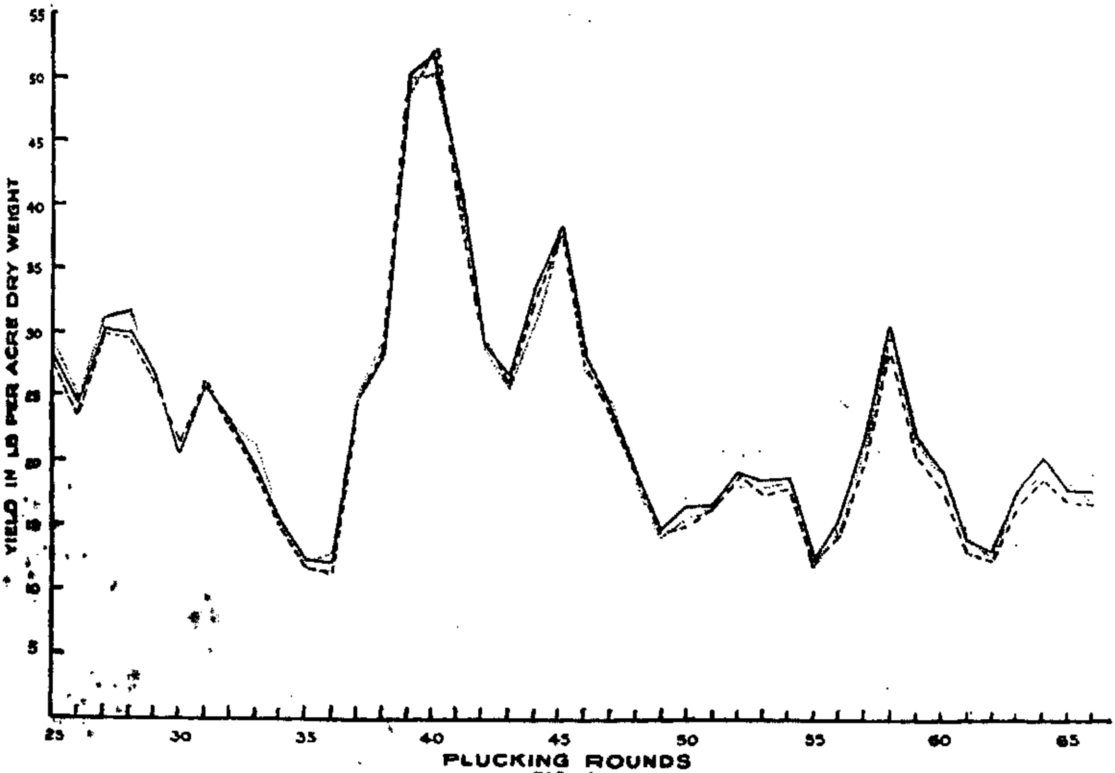

FIG. 4.

YIELD PER ACRE FROM PLOTS RECEIVING VARIOUS QUANTITIES OF POTASH

SOLID LINE 40 LB POTASH PER ACRE
BROKEN LINE 20 LB POTASH PER ACRE
DOTTED LINE NIL

FIG. 3 FIRST YEAR (1931)
FIG. 4 SECOND YEAR (1932)

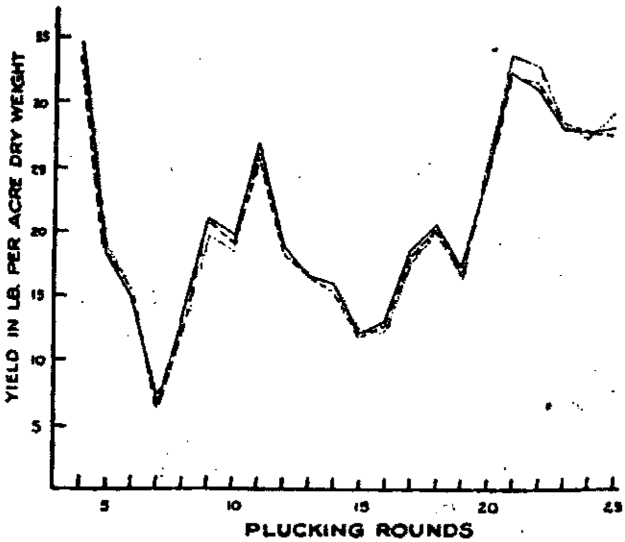

FIG. 3.

TABLE II

Yield of Flush (1st Year.)

	Nitrogen Quantities			Potash Quantities			Nitrogen Type		
	Nil	20 lb. per acre	40 lb. per acre	Nil	20 lb. per acre	40 lb. per acre	Blood meal	Cyan-amide	Sulphate of ammonia
Yield per acre lb. dry weight.	502	516	527	518	509	517	523	518	523
Significant difference lb.		28·3			28·3			34·9	
Yield per cent of mean.	97·5	100·2	102·3	100·5	99·0	100·5	100·3	99·4	100·3
Significant difference per cent.		5·5			5·5			6·7	

The yields and percentages are self-explanatory; the values for significant differences are derived from the error figures, and in this form the implications of "error" will I hope be more readily appreciated. Within the groups to which they refer, differences of yield larger than the significant difference can confidently be regarded as due to difference in treatment.

None of the treatments has had any considerable effect compared with its fellows. In fact in these two tables the effect of nitrogen on tippings is the only one that exceeds the prescribed limit. Between the no nitrogen and the 40 pounds per acre treatment there is a difference of 9·6 per cent which in relation to a significant differanee of 7·4 per cent must be regarded as real.

It is of particular interest that this effect shows up for tippings and not for the flush over the whole period of a year, and consequently the figures justify further and closer examination.

A feature of the nitrogen yields which is not shared by the potash yields is that both for tippings and flush, they form an ascending series with increased manurial application. In the case of tippings just dealt with, a definitely valid yield increase has been demonstrated, but not so for the flush. The fact that this regularity does exist and that it fits in with the design of the experiment allows of a more refined test to be made with a view to determining whether we are justified in supposing that the differences are truly connected with treatment. This test has been applied to the nitrogen yields for flush, but with negative results. Using the most refined technique available, we cannot confidently assert that flush yields have responded to nitrogen.

In passing we may emphasize again that potash, with a maximum difference of 1·5 per cent, has produced no response, and that the three types of nitrogen, all within one per cent of each other, show no difference in productive capacity. In order that you may see not only how these different plot treatments have behaved in the mass, but throughout the year the yield curves for the individual pluckings are given in Figures 1, 3 and 5. You will notice how no one treatment maintains a consistent superiority. It is this erratic behaviour due to chance causes that constitutes the errors with which have to deal.

Table 3 shows the yields of flush for the second year of the pruning cycle.

TABLE III

Yields of Flush (2nd Year.)

	Nitrogen Quantities			Potash Quantities			Nitrogen Type		
	Nil	20 lb. per acre	40 lb. per acre	Nil	20 lb. per acre	40 lb. per acre	Blood meal	Cyanamide	Sulphate of ammonia
Yield per acre lb. dry weight.	878	942	1025	952	932	961	990	967	994
Significant difference lb.		48·9			48·9			59·9	
Yield per cent of mean.	92·6	99·4	108·0	100·4	98·3	101·3	100·7	98·3	101·0
Significant difference per cent.		5·16			5·16			6·30	

In the second year, potash and the three types of nitrogen behave in a similar manner to the first year giving only minute differences in yield not exceeding 3 and 2·7 per cent respectively, to which no reality can be attributed. The increments of nitrogen have on the other hand borne fruit throughout the year (*cf*. Figs. 2, 4 & 6)

Plate IV.

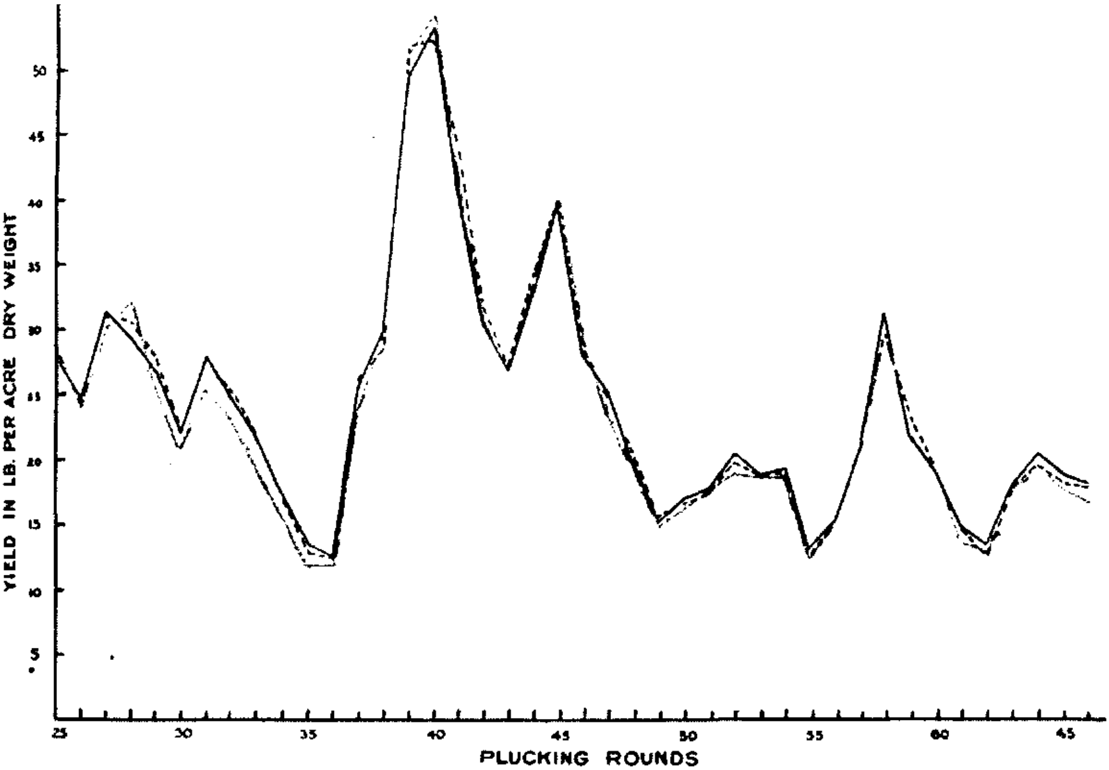

FIG. 6.

YIELDS PER ACRE FROM PLOTS RECEIVING EQUIVALENT QUANTITIES OF NITROGENOUS FERTILISER IN DIFFERENT FORMS

SOLID LINE — *BLOOD MEAL*
BROKEN LINE — *SULPHATE OF AMMONIA*
DOTTED LINE — *CYANAMIDE*

FIG. 5 FIRST YEAR 1931
FIG 6 SECOND YEAR 1932

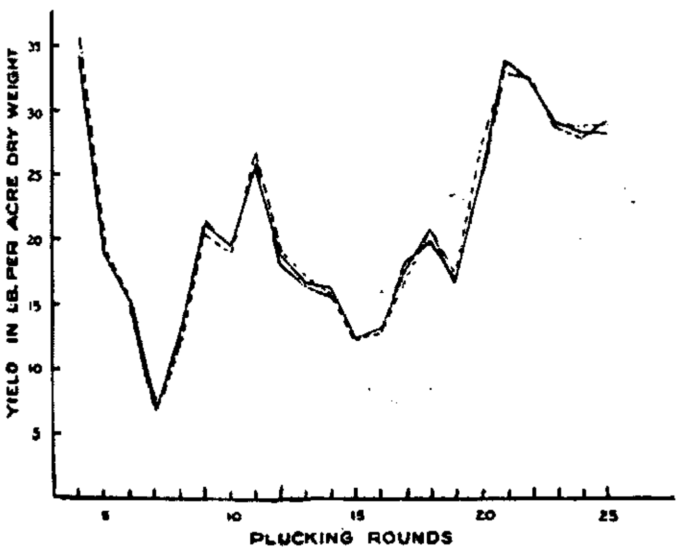

FIG. 5.

giving a gross increase of more than 15 per cent for the 40-pound application. There is no shadow of doubt that both doses have given an effective response. It is worthy of note that the increase in yield obtained from the doubling of the dose of nitrogen shows no sign of a falling off compared with the response of the first 20 pounds. Under the conditions of the experiment, 40 pounds of nitrogen have not brought yields into that region where the law of diminishing returns operates.

DISCUSSION OF RESULTS.

So far we have considered the yields only in the light of differences which can be authoritatively stated to be due to the treatments given. It remains to consider whether, real as some of them may be, they are of agricultural importance, and what inductions of wider scope may be drawn from them.

The most interesting point in the experiment is to my mind the evidence for an early response to nitrogen after pruning which is not maintained in the latter stages. It is usual, when crop forecasts are not confirmed, to blame the weather, but it is more than possible that in this case weather is the right explanation. At any rate, something limited the usefulness of the nitrogen in the latter half of the year, and 1931 was by common consent a year of heavy monsoon activity. It may be that further work will show this first year to be abnormal; or it may be that the phenomenon is a usual one. On this particular point the experiment has asked a question rather than answered it, but since it is asked in a concrete form, some progress has been made. An experiment should always ask questions as well as answer them.

The failure to establish any response to potash manuring is a point of fundamental importance. Potash is necessary to the tea plant and as a matter of fact its leaves contain a high percentage relative to many other types of vegetation. We are not justified in concluding forthwith that potash manuring can be stopped. We have yet to determine how far this nil response is due to latent supplies caused by possible over-manuring in the past. The further progress of the experiment will show how soon a falling off of available supplies comes into action. It may be objected that though flush is not affected by potash the wood is. That view is an integral part of the "watertight compartment" theory that has no very solid foundation. If potash deficiency affects any portion of the growing plant its results will ultimately be reflected in yields.

Finally, there is the behaviour of the Bloodmeal, Cyanamide and Sulphate of Ammonia. Into this aspect of the experiment the question of reserves does not enter. The organic, the intermediate and the inorganic types were given an equal trial and the result for all practical purposes was a dead heat. The data for the first year contribute little information, because the response to nitrogen being nil, it naturally is immaterial in what form it is supplied. We shall complete the pruning cycle and shall continue into another in order to make assurance doubly sure, but since these are objective results I believe they can be acted upon up to a point now.

If manuring is dropped then the yield will decline, not rapidly but a few percent at a time. These experiments give two years' grace to a scheme for economising on manures. Let potash dressings be moderate, say 20 pounds per annum, and make the best use possible of inorganic forms of nitrogen in the moderate doses covered by these results. If a slow decline sets in, the degree of accuracy to which we can work will detect it, and due warning can be and will be given.

The results I have put before you have been confined to the field aspects of manuring; that does not mean that we are unmindful of the effect of manuring on the quality of the made tea. Consideration of this aspect will form part of Dr. Evans' discourse this afternoon.