THE AIM OF FIELD EXPERIMENTS, I.

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The Report of one of the District Planters' Associations, commenting on the preference for flat land urged in connection with the acquirement of an experimental estate for the Institute, concludes—" One would imagine moreover, that an average estate—fairly steep and rocky—such as 90% of those in Ceylon are, would provide more useful information than could be obtained from an ideal one." Since this view, which is apparently widespread, is based upon a misconception of the nature, scope, and limitations of field experiments, it is proposed in this and a later article to deal first with the nature of agricultural field experiments and their aim, and subsequently with the methods by which the undoubted difficulties can be overcome.

It will simplify the argument if the whole question is discussed in terms of a concrete example, and the manurial trial will be used for this purpose. Exactly the same reasoning would hold however if the experiment were concerned with pruning or some system of cultivation.

Now before a planter distributes over his land a considerable amount of more or less expensive manure he wishes to satisfy himself that a benefit is going to be derived from that application. In his mind's eye, he has to compare the yield and condition of the tea on his estate, or on a portion of it, with that which the *same piece of land* would produce in the absence of any manurial application. The phrase " the same piece of land " is in this connection of the utmost importance, because it lies at the root of all, or nearly all, of the differences of opinion between the experimenter and the practical man.

It will be obvious that the exact answer to the question is one which it is impossible to give, because it is not practicable to obtain a measure of yield on that chosen area of land under the two treatments, manured and unmanured, at one and the same time. It is of no use trying the plot unmanured one year or through one pruning cycle, and manured during a subsequent period, because although the actual plot of land is the same the seasons are proverbially unstable. What therefore one has gained in one direction has been lost in another.

The same sort of situation is created when two plots are used at the same time, one manured and the other untreated. This, however, is always the method one chooses, because it is the lesser of two evils and takes less time. As soon then as one embarks upon field experiments, one is inevitably putting one's hand to a procedure which will not give a direct answer to the question " how much benefit would this treatment give me on this piece of land." It can only give a close

approximation to the answer desired. The aim of field experimental method and the business of the experimenter is to make that approximation as close as possible.

The fact that must be realized at the outset is that field experiments are a compromise between what we want to know and what we can succeed in getting to know. It is just as impracticable to ask for what cannot be given, as it is to give something which is distantly removed from the conditions under which the practical man has to work. What then can the experimenter give in place of the ideal ?

He can give results which shall be as *comparable* as he knows how to make them. He must start by choosing experimental land which gives a reasonable hope that an apparent response to treatment is not due to the fact that the ground where he applied the manure was initially better than that which he has designated 'control,' and *vice versa*. That differences of a magnitude great enough to cause such results do exist, even in adjoining patches of land, is now largely recognized by experimenters. Every inadequate experiment which is added to the only too numerous collection of its forerunners accentuates the importance of the maxim that soil heterogeneity is one of the greatest of enemies. It is no remedy to increase or decrease the size of plots beyond a certain limit in the hope of levelling out soil differences, for by so doing other difficulties crop up which will be considered later.

The point has been made that the essence of an agricultural experiment is the provision of adequate comparisons. These should undoubtedly be made on the basis of as normal practice as is possible, but where normal practice fails to afford adequate comparison some slight modification must be made. Otherwise, no matter how practical and imposing the superstructure may look, the foundations are lacking. It must not be supposed that these modifications will be anything but small, and in considering them care must be exercised in deciding what are essentials and what are not. The loss of typicalness entailed by modifications requisite for experimental methods is small compared with the loss of accuracy and reliability to which the neglect of such methods would give rise.

This view, moreover, is not mere speculation, but the broad result of many years' intensive study of field experimental technique. More and more in recent years it has been realized that an agricultural experiment is not a thing to be laid down lightly and without thought, but demands careful consideration and a considerable amount of preliminary ground-work. For agricultural crops in temperate climates. this ground-work knowledge has been accumulating ever since Lawes started the classical experiments at Rothamsted in 1843; hence the comparative success of such trials. For tea it has still to be worked out.

It remains to apply these general considerations to the point in question, the type of land suitable for tea experiments, more parti-

cularly as outlined in the quoted extract at the beginning of this article. Comparability of plots of land suitable for experimental purposes depends very largely on two factors, drainage and soil depth. Unformity of either is unattainable on rocky land. Drainage is modified appreciably for some distance round large boulders and rocks; soil erosion is held up by boulders and rocks acting as terraces, and the accumulated soil results in the establishment of variable soil depths. In addition to these complications variable wind shelter is afforded to the tea by boulders. All these variable factors affect the crop to an unknown extent, and confuse the issue as to whether the manurial treatment is or is not solely responsible for any apparent benefit. The presence of a large rock in plots of the size which can be contemplated for experiments, would render those plots hopelessly incomparable with others not identically supplied. It may be suggested that if a number of such rocks were encountered in laying out an experiment, the small areas around them might be discarded. But the omission of such areas is surely a very cogent argument for choosing land in the first instance where these conditions do not occur.

One is very little better off with flat land in the sense in which such a description is interpreted in Ceylon. Really flat land is of course more uniform in soil depth and drainage than any other, but such land does not exist in the tea districts of Ceylon, judging by the writer's admittedly limited experience. What is commonly spoken of as flat land in Ceylon is land that has no very pronounced gradient and is usually made up of small undulations or knolls. The drainage in such cases runs in a number of directions; the soil varies in depth owing to the folds and pockets produced by the undulations, and moreover does not vary in an orderly fashion. The simple expedient of driving a walking stick into such ground gives a convincing proof of the variation of soil depth. Consequently such land is poor experimental land. It is erroneous to suppose, as would be inferred from a sentence preceding the extract already quoted, that the Tea Research Institute is seeking an estate where this 'flat' land preponderates.

What is urgently required is land uniform in slope over moderate sized areas. It is immaterial whether the slope is relatively great or small, provided that large rocks are absent. Such slopes, if they are gentle, are likely to have a reasonably uniform soil depth and their drainage will be constant too. If steep, then whilst the drainage and soil depth may change, they will change in a progressive manner, and not a haphazard one as is the case with boulder land and small folds. Such constant variation can be coped with in modernly-designed experiments. It is to this type of land that one looks to provide a suitable site for experiments, one, moreover, which will satisfy the legitimate requirements of the experimenter who aims at comparable plots, and the equally legitimate demands of the practical man for experiments that shall not be of academic interest only.