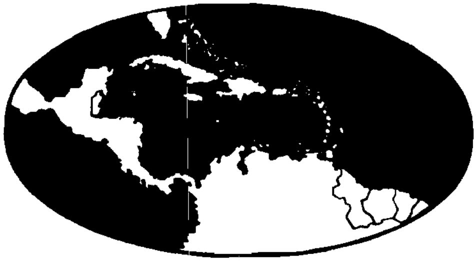
CARIBBEAN FOOD CROPS SOCIETY



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THE IMPORTANCE OF CORRECT DESIGN AND RANDOMISATION IN LAYING OUT STATISTICAL FIELD TRIALS

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SUMMARY

All over the world experimenters often make mistakes in the design or layout of their field trials. As a result the results of the experiment become difficult if not almost impossible to analyse statistically. Some of the more common mistakes are pin-pointed and suggestions are made as to how to overcome these mistakes.

INTRODUCTION

A very common problem encountered by the agricultural research worker is to investigate the behaviour of a food crop under certain conditions. He may for example wish to investigate the growth and harvest in different climatic or geographical situations. Alternatively he may wish to observe the behaviour of the crop under varying amounts of some nutrient or the behaviour with different nutrients applied singly or in combination with each other. Sometimes the research worker may want to investigate many or all of the above factors on the same crop. The researcher will normally proceed by setting up a field trial to investigate the factors in which he is interested.

Having decided upon the factors for investigation and the need for a field trial the experimenter must decide upon a suitable experimental design for his trial. He may decide upon a simple type of design such as a completely randomised or randomised block design. Alternatively he may decide upon a more complex design say a lattice design or again he may decide upon a Modified Composite Design (Lauckner 1974). To obtain the best design for his problem he may consult a biometrician or he may consult one of the standard text books such as Cochran and Cox (1966) or Le Clerg *et al.* (1966). Once the researcher has decided upon a suitable design there then follows the problem of planting the experiment in the field. At this stage many mistakes occur. On some occasions the experiment is not laid out in the correct design chosen;

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on other occasions treatments are not applied correctly to the plots. Mistakes like these usually considerably reduce the information which can be drawn from the results of the experiment. In some cases they may even render the experiment almost completely useless. With the aid of an example we will now look at the design and planting of an experiment and try to suggest ways of eliminating mistakes.

A PIGEON PEA EXPERIMENT

Let us suppose that a soil scientist wishes to investigate the effect upon the yield of pigeon peas when various nutrients are added to the soil. The nutrients under study are Nitrogen (N), Phosphorous (P), Potassium (K) and Magnesium (Mg). Two dressings of each nutrient are to be applied - low and high, but there are no control dressings as the scientist is satisfied that some form of fertilizer is desirable for the soil and crop under experiment.

With the help of a biometrician it is decided to set up a 2^4 factorial experiment with the fourth order interaction ABCD confounded. The advantage of this is that the ABCD interaction is unlikely to be of much interest and also the block size can be reduced to manageable proportions. The experimenter consults Cochran and Cox (1966) for a field plan and he finds the following plan number 6.2 at the end of chapter 6;

2^4 factorial, blocks of 8 units
Rep. 1, ABCD confounded

a	(1)
b	ab
c	ac
d	bc
abc	ad
abd	bd
acd	cd
bcd	abcd

This plan shows two blocks with eight treatments in each block. In our example a, b, c; d refer to the nutrients N, P, K and Mg. Presence of the letter means that we apply the high dressing of the nutrient, absence of the letter means that we apply the low dressing. Thus, a means high N, low P, K and Mg whereas abc means high N, P and K and low Mg. (1) means the low dressing of all the nutrients and abcd the high dressing of all the nutrients.

The experimenter decides to conduct his experiment with four blocks laid out as in figure 1. This means that the field plan is repeated twice, once for blocks 1 and 2 and once for blocks 3 and 4.

The next task for the experimenter is to randomise the field plan and place treatments in the 32 plots of figure 1. Failure to do this correctly could seriously undermine the whole value of the experiment. First he must assign the blocks in the plan to the block in the field. Blocks 1 and 2 form the first replication so they must contain the two blocks in the plan, not the same block twice. Blocks 3 and 4 form the second replication. Deciding which block of treatments to put in Block 1 can be done simply by tossing a coin, then block 2 will have the other block of treatments. The choice of treatment blocks for blocks 3 and 4 depend upon the field where we are experimenting. If it is thought to be uniform then another coin can be tossed to determine placing of blocks. If however by virtue of slope or wind direction one end of the field has differences from the other, then it will probably be best to try to compensate for this by placing similar blocks on the outside blocks 1 and 4 and also the inside blocks 2 and 3. Some fields may be more fertile in the middle so in this case blocks 2 and 3 would receive different treatments.

Let us suppose that the coin decrees that Block 1 receives the right hand block in the plan i.e. the treatments (1), ab, ac, bc, ad, bd, cd and abc. It is most important to see that this block receives each of these treatments once and once only. Placing the wrong treatments in the wrong blocks or missing out some treatments completely and giving other treatments extra replication has ruined many trials of this sort.

The eight treatments named above have to be placed in plots 1 to 8 in random order. This is best done by use of random number tables. The treatments above are numbered from 1 to 8. Starting from some suitable point in the tables we read the numbers until we arrive at one of the numbers from 1 to 8. Suppose this is 6. Then we place the sixth treatment, bd (high P, high Mg, low N, low K) in plot 1. We continue reading numbers from the tables until we arrive at a number 1, 2, 3, 4, 5, 7 or 8. N.B. We ignore any further 6's as we have already placed treatment 6 in the block. We continue until all plots in the blocks have been allocated treatments and then repeat the process for the other three blocks.

It cannot be emphasised too strongly that randomisation should be carried out correctly and that the treatment combinations are assigned to the correct blocks. Thus, before laying the experiment in the field a careful check of the design should be made to ensure that no

1	9	17	25
2	10	18	26
3	11	19	27
4	12	20	28
5	13	21	29
6	14	22	30
7	15	23	31
8	16	24	32
Block 1	Block 2	Block 3	Block 4

Fig. 1. Field Lay Out of Pigeon Pea Trial

mistakes have arisen. If the experimenter is a little uncertain on these points then he should not hesitate to show his field plan to a biometrician who will check it for correctness.

Further disastrous, errors can occur when laying out the experiment in the field. Great care must be taken to ensure that each plot receives the correct nutrients. Unfortunately many trials such as this one are spoilt by not applying the correct treatments to the correct plots. In an experiment such as this it is strongly recommended that the fertilizer is placed in numbered bags - the number referring to the plot on which the fertilizer is to be applied. Each worker should then match these numbers to the field plan or better still numbered stakes on the plot to be treated. Often little can be done to salvage an experiment which has been spoilt by incorrect application of treatments.

CONCLUSION

Most of the suggestions in this paper will probably sound fairly trivial to experimenters in the Caribbean region. However, in this region, as elsewhere field trials have been reduced in value by making the mistakes which have been mentioned. It is therefore suggested that experimenters make efforts to carryout the procedures as recommended in this paper to ensure they get as much information as is hoped when planning an experiment.

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