Design of Experiments: Agriculture or Medicine?

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Steps in the design of an experiment

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Step 1 Give a full description of the set of treatments. These may have no particular structure; they may all combinations of levels of two treatment factors; they may include a control treatment; and so on.

Step 2 Give a full description of the set of experimental units. They may be unstructured; they may be grouped into blocks (for example, by health centre, by gender, or by severity of symptoms). In Agriculture, if an experiment takes place in multiple farms over many years then both Farms and Years are considered as blocking systems. Then the factor whose levels are the combinations of Farm and Year is also be considered as a blocking system. That approach to blocking is rare in medical experiments.

Further steps

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Step 6 The treatment space is divided into subspaces for main effects and interactions. If the design is orthogonal, then each of these subspaces is contained in a single stratum. The null ANOVA table is then expanded to the skeleton ANOVA table by including all these subspaces and then showing the number of residual degrees of freedom in each stratum.

An example

An experiment to investigate combinations of three varieties of rye-grass with four quantities of fertilizer was carried out using two fields. Each field was divided into three long strips, with one variety sown on each. Each strip was divided into four plots, with a different quantity of fertilizer in each plot.

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Skeleton anova

Stratum	Source	df	
Mean	Mean		1
Fields	Fields		1
Strips in F	Varieties	2	
	Residual	2	
	Total		4
Plots in S	Fertilizer	3	
	V-by-F	6	
	Residual	9	
	Total		18

Last steps

This is all done before the experiment takes place. If any stratum has zero residual degrees of freedom then the proposed design is useless. If any stratum containing a treatment subspace has a very small number of residual degrees of freedom, there may be little chance of detecting significant treatment effects in that stratum.
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You may test block effects. Even if there is no evidence that these effects are non-zero, do not remove them from the model, because this introduces subtle biases.

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Blocking The attitude to blocking is quite different. When reading a research paper which reports the results of an experiment, it can be hard to work out exactly what the blocks were, what their size was, whether combinations of levels of two block factors were also considered to give a block factor, ...

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Rebecca and I find this all very frustrating!