



# BIOMETRICS INFORMATION

(You're 95% likely to need this information)

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PAMPHLET NO. # 17

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SUBJECT: What is the Design?

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When discussing clients' experiments I will often ask: "What is the design?" Since the meaning of this question is often unclear it has been suggested that I explain it in a pamphlet.

When I ask for the design of an experiment I am asking many questions at once. Questions such as:

1. What are the treatments?
2. How are they related to each other? e.g. are they in a factorial arrangement (i.e. **CROSSED**).
3. How are the treatments replicated?
4. What are the experimental or treatment units (t.u.'s)?
5. What are the sampling units (s.u.'s)? i.e. what objects are actually measured?
6. How will the treatments be assigned to the t.u.'s?

This last question provides the basic information required to determine the **DESIGN** of the experiment. The answer will describe in what way the random assignment of treatments to the t.u.'s will be restricted.

Treatment assignment is not restricted in a completely randomized design (**CRD**), while treatment levels in a randomized block design (**RBD**) are assigned a given number of t.u.'s within each block (usually one t.u. per treatment level per block). Split-plot designs are identified by the existence of 2 or more different **KINDS** of t.u.'s; each assigned levels from different treatments.

As an example, suppose that an experiment has two treatments: 2 types of site preparation (**P**) and 4 stocktypes (**S**). If each stocktype is planted with each site prep then the two treatments, **P** and **S**, are **CROSSED** (denoted by **P\*S**). If each stocktype is planted with only one site prep type then stocktype is **NESTED** within site prep (denoted by **S(P)**). The crossed arrangement will have a total of 8 treatments while the nested has only 4.

Suppose that the experiment will have **S** and **P** crossed and that the basic t.u. will be 25 trees arranged in a 5 x 5 square. If there are 3 t.u.'s per treatment level then there are a total of 600 trees in the experiment. The way in which the t.u.'s are arranged and the 8 treatments assigned to them will determine the design. The following describes the treatment assignment for the most common designs.

1. **COMPLETELY RANDOMIZED DESIGN (CRD)**: Within a large homogeneous area 24 square plots are identified as suitable for planting. Each site prep and stocktype combination is randomly assigned 3 plots (t.u.'s) each.

2. **RANDOMIZED BLOCK DESIGN (RBD):** Three blocks of land are identified as relatively homogeneous or similar within each block although there might be quite large differences between blocks. In fact, if it is believed that there are not differences between blocks then RBD is inappropriate. Each block is split into 8 square plots (t.u.'s). Each plot is then randomly assigned one of the 8 treatments.

Schematic layouts for these 2 designs are shown below. The first digit refers to the site prep treatment while the second digit refers to the stock type (the random numbers were obtained using PROC PLAN in SAS).

**COMPLETELY RANDOMIZED DESIGN:**

22	22	12	21	14	24
12	13	11	23	11	23
24	14	22	23	21	12
13	11	24	14	21	13

**RANDOMIZED BLOCK DESIGN:**

BLOCK 1

14	24
21	12
13	22
11	23

BLOCK 2

23	13
21	24
14	11
22	12

BLOCK 3

12	14
11	13
24	22
23	21

The previous two designs become split-plot designs if groups of 4 plots are formed into mainplots and randomly assigned site prep treatments. Since site prep must often be assigned to large t.u.'s this is a common practice. The stocktype is then randomly assigned to one of the 4 plots (split-plots) within the mainplot. Thus the t.u. for site prep is a group of 4 plots while the t.u. for stocktype is one of those 4 plots. The schematic layouts change accordingly:

### COMPLETELY RANDOMIZED SPLIT-PLOT DESIGN:

SITE PREP TREATMENT:

2            2            1            2            1            1

MAINPLOT NUMBER:

1            2            3            4            5            6

2	1	1	1	4	3
3	4	2	4	2	4
4	3	4	2	3	2
1	2	3	3	1	1

**RANDOMIZED BLOCK SPLIT-PLOT DESIGN:**

BLOCK 1

BLOCK 2

BLOCK 3

SITE PREP TREATMENT:

1      2

2      1

2      1

MAINPLOT NUMBER:

1      2

3      4

5      6

2	4
3	1
4	2
1	3

1	2
4	1
3	3
2	4

1	3
2	2
4	1
3	4

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