Some Standard Designs

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Completely Randomized Designs ①

- Every experimental unit is randomly assigned to one of the treatments.
- Used when there are no blocks (no know nuisance var. to control).

It is a design in which the experimental units are assigned to the treatments completely at random, subject only to the number of observations to be taken on each treatment. It is used when an experiment involves no blocks.

Example:

- Testing 3 fertilizers on 30 plots of land, with no known differences in the plots.
- Randomly assign 10 plots to each fertilizer.

Strengths:

- Simplicity
- Easy to analyze

Limitation:

- If units vary (e.g., sunlight, soil), this variation is absorbed into the error term.

Block Designs ② $\boxed{\text{Purpose}}$: To control for known sources of variability among units.

- Units are grouped into blocks of similar characteristics.
- Within each block, treatments are randomly assigned.

In a block design, the experimenters partition the experimental units into blocks, determine the allocation of treatments to blocks, and assign the experimental units within each block to the treatments completely at random. Note the random assignments take place within each block, that is a key difference with completely randomized designs.

- Complete block designs: each treatment is observed the same number of times. If each treatment is observed only once in each block, the design is a randomized complete block design or, simply, randomized block design.
  - Each treatment appears once in every block.

Example (Agriculture):

- Each block is a field with similar soil.
- Apply all treatments once in each field.

Ex) Randomized Complete Block Design (RCBD)

↳ Most common block design

↳ All treatments used in every block.

Block Designs

- Incomplete block design: when the block size (i.e., the number of experimental units in the block) is smaller than the number of treatments, not all treatments can be observed in a block. The design is an incomplete design.

- Block size ($<$) smaller than the number of treatments.
- Not all treatments appear in each block.

Used when:

- It's infeasible to test all treatments per block (e.g., due to cost, time).

Designs with Two or More Blocking Factors ③

∘ Two blocking factors (row/column) that are crossed.
∘ Each level of one factor occurs with each level of the other.

- **Row-Column Design:** a design involving two crossed blocking factors. Factors are crossed if all combinations of levels of the factors are used.

  Example:
  - Tasting experiments: rows = tasters, columns = time of day.

  ∘ Levels of one blocking factor are nested within another.

- **Nested (or hierarchical) blocking factors:** Factors are nested if a particular level of one of the factors occurs at only one level of the other factor.

  Example:
  - Cotton samples from batches from different suppliers:
    - Samples ⊂ Batches ⊂ Suppliers

For example, the experiment units may be samples of some experimental material(e.g., cotton) taken from several different batches that are from different suppliers. The samples, which are to be assigned to the treatments, are nested within batches, and the batches are nested within suppliers.

Split-Plot Designs ④

∘ Used when it's hard or expensive to apply to one factor, but easier to apply another.

Structure:

↳ whole-plots: Large units get one level of a hard-to-change factor,

↳ Sub-plots: Smaller divisions inside whole-plots, each gets a level of a second factor.

Commonly used in agricultural experiments. This design facilitates easier implementation. It involves a two-stage randomization: The levels of one factor is assigned to large experimental units (whole plots) that are split into smaller units (sub-plots). Levels of another factor are assigned to sub-plots. Usually the treatments assigned to the whole plots are harder to change.

Example:

- Factor A: Irrigation (assigned to entire fields)
- Factor B: Fertilizer (applied to subplots within fields)

Advantages:

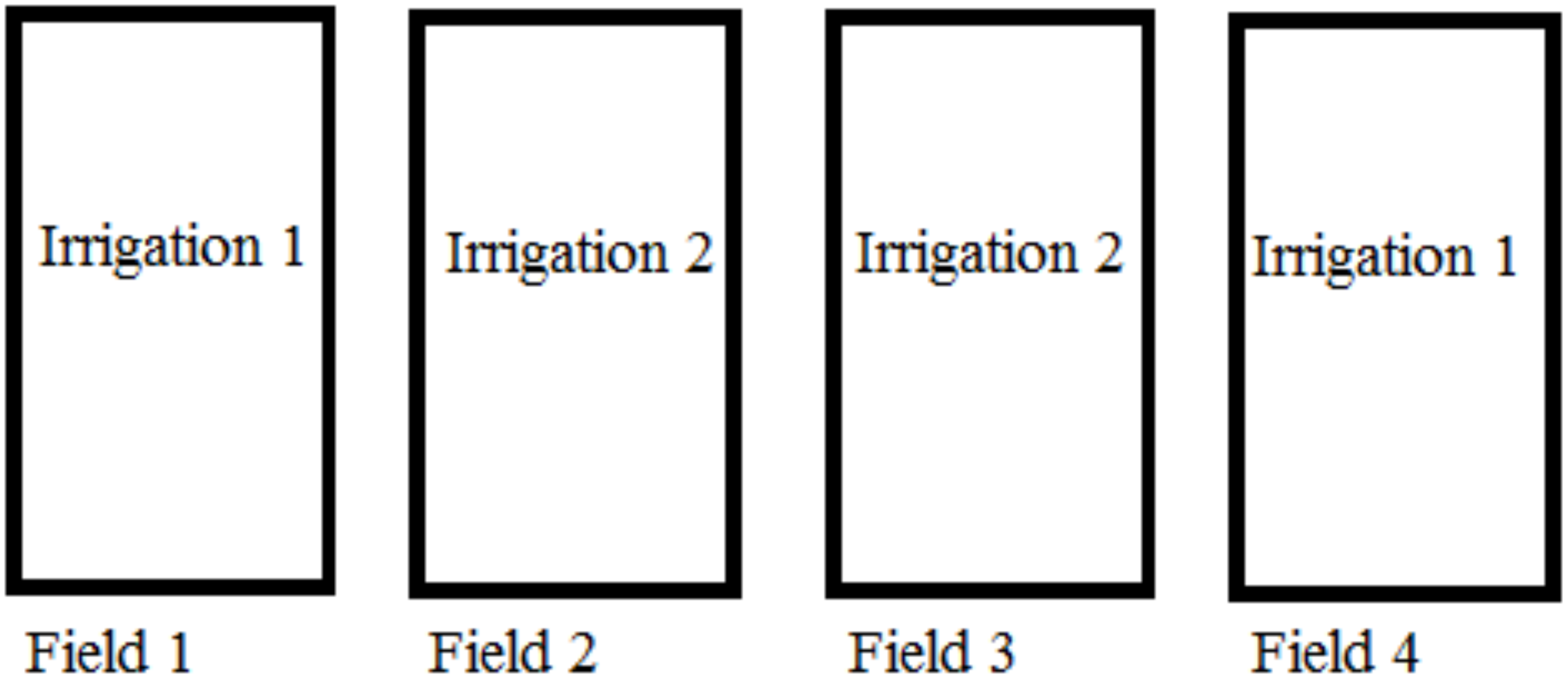
- Easier logistics when one factor is hard to change.
- Reflects real-world conditions more closely.

Note: Requires **special statistical models** for proper analysis due to different error terms for whole-plot and sub-plot factors.

Example of Split-Plot Design

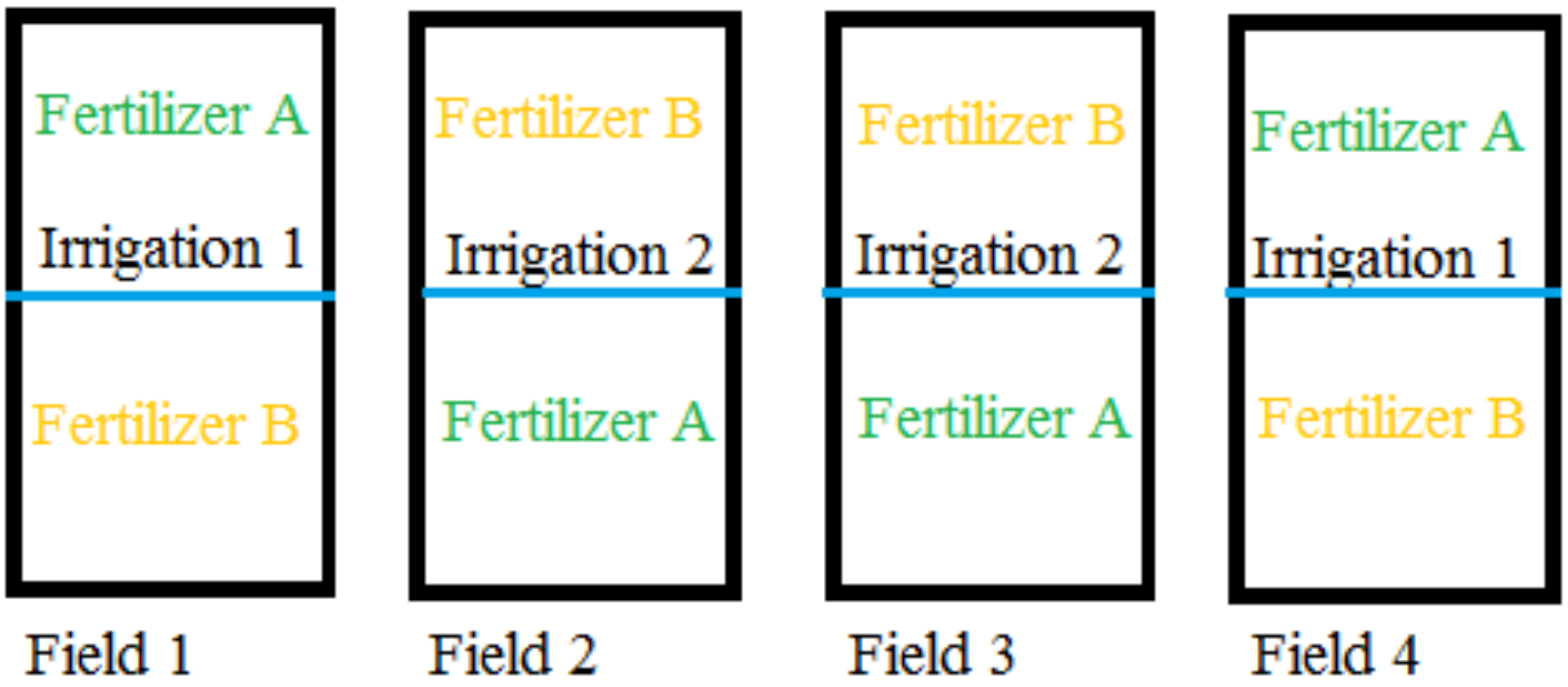
Consider two factors: Irrigation method (with two levels) and fertilizer (with two levels).

The two irrigation methods are randomly assigned to 4 large fields (whole plots):



Example of Split-Plot Design

Each whole plot is then divided into two sub-plots and the two fertilizers are randomly assigned to the sub-plots.



Additional Reading

Sections 2.4 and 2.5. Read the examples of the real experiment and study how the checklist is followed through.