Design Guide

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Understanding Your Constraints

Let's start with the basic facts:

- **Total experimental units per greenhouse per season:** 16 plots
- **Factors you need to test:**
  - Heat levels: 1, 2, 3, 4
  - Light levels: 1, 2, 3, 4
  - Variety: Redhot (R) and Furious (F)
  - Side orientation: North (n) and South (s)

Question 1: How many treatment combinations exist?

If you wanted to test every possible combination of heat, light, variety, and side, how many combinations would that be?

Calculate: $4 \times 4 \times 2 \times 2 = ?$

Key Design Principles

Principle 1: Orthogonality (Balance)

Your design should ensure that: - Each level of one factor is paired with each level of another factor **equally often** - No factor should be systematically linked to (confounded with) another factor

Example of confounding to AVOID: If you always put Redhot on the north side and Furious on the south side, you've confounded variety with side. You won't know if differences in quality are due to variety or to sun exposure.

Principle 2: Blocking

You have two greenhouses (A and B) and will run the experiment over two seasons (1, 2). These are natural "blocks" because: - Environmental conditions differ between greenhouses - Growing conditions differ between years

Your design should account for this structure so that differences between greenhouses/seasons don't distort your main conclusions.

Principle 3: Replication

With only 16 plots, you can't replicate every single treatment combination many times. But within your constraints, treatments should appear multiple times so you can estimate uncertainty.

Designing Your Experiment: Step by Step

Step 1: Identify Your Factors

List out: - What are your experimental factors? - Which are your blocking factors? - Which is your response variable?

Step 2: Think About Confounding

Ask yourself: - If I assign variety randomly to plots, might it accidentally correlate with side orientation? - How can I prevent systematic relationships between factors?

Step 3: Paper-and-Pencil Design

Before you touch R, **draw your design on paper**.

Suggestion: Draw a **4 × 4 grid** representing your 16 plots in one greenhouse/season.

- Label rows with one factor (e.g., heat levels 1, 2, 3, 4)
- Label columns with another factor (e.g., light levels 1, 2, 3, 4)
- Fill in each cell with your assignment of the remaining factors (variety and side)

Constraints for your grid: - Each combination of (variety, side) should appear exactly once in each row - Each combination of (variety, side) should appear exactly once in each column - This ensures orthogonality—no confounding!

Step 4: Check Your Design

Before coding, verify:

1. Does each (variety, side) combination appear in every row? Count them.
2. Does each (variety, side) combination appear in every column? Count them.
3. Are there any systematic patterns that would confound factors?
4. Can you describe in words what your design does?

Questions to Guide Your Thinking

Answer these before you code:

1. **What are you trying to learn?** (Hint: re-read the farmer's questions at the start of the project)

2. **What is a "block" in your experiment?** How will you account for it in your design and analysis?

3. **What does "orthogonal" mean in the context of your design?** Give an example from your design.

4. **Why is it important that variety doesn't correlate with side?** What would happen if it did?
5. **For each factor, how many times will each level appear across all 16 plots?**

   - Heat level 1: _____ times
   - Light level 1: _____ times
   - Variety "R": _____ times
   - Side "n": _____ times

6. **What design principle or structure does your grid follow?** (There's a name for this type of design.)

Final Note

Once you've drawn your design and answered the above questions:

1. Create a `design.csv` file with one row per plot
2. Columns should be: `season`, `greenhouse`, `plot`, `heat`, `light`, `variety`, `side`
3. Use the factor level codes specified in the project instructions
4. Your 64 rows will represent: 2 seasons × 2 greenhouses × 16 plots

Then you'll be ready to use `get.observations()` on your design.